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TRAVELS

IN THE

TWO SICILIES,

AND

85926

SOME PARTS OF THE APENNINES.

Tranſlated from the Original Italian of the

ABBE LAZZARO SPALLANZANI,

Profeſſor-Royal of Natural Hiſtory in the Univerſity of Pavia, and Superintendant of the Imperial Muſeum in that City; Fellow of the Royal Society of London; and Member of the Academies of Pruſſia, Stockholm, Gottingen, Turin, Padua, &c. &c.

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IN FOUR VOLUMES.——WITH ELEVEN PLATES.

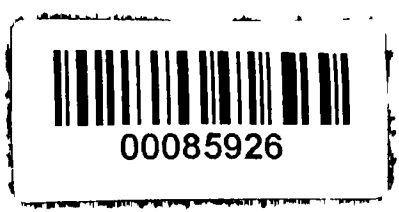
VOL. I.

LONDON:

PRINTED FOR G. G. AND J. ROBINSON,

PATERNOSTER-ROW.

1798.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ADVERTISEMENT

BY THE

TRANSLATOR.

THE name and eſtabliſhed reputation of the Abbé Spallanzani muſt certainly be a ſufficient recommendation of any work he gives to the public, eſpecially of one like the preſent, on which he appears to have beſtowed a more than ordinary degree of labour and attention. The variety of objects, highly intereſting to the naturaliſt and the philoſopher, on which it treats, may be ſeen in the following introduction, which contains, in part, a ſummary of the work.

In the tranſlation, fidelity and accuracy have been principally ſtudied. The reader, it is preſumed, has before him a faithful tranſcript of the original (if the expreſſion may be allowed) in his own language. Where the meaning admitted of no doubt, the tranſlator thought himſelf at liberty to depart from the phraſeology of his author, to give his idea with greater perſpicuity; a licence which the different idioms of language will frequently render neceſſary: but where any ſhadow of ambiguity appeared (and in every work, eſpecially works of ſcience, ſuch ambiguities of expreſſion will occaſionally be found) he has ſcrupulouſly adhered to the literal expreſſion of his text, that the reader may be enabled to form his judgment in the ſame manner as from the original.

As the Abbé has continually employed the

the terms of what is called the new nomenclature of chemiſtry; it has been thought proper, for the beneſit of readers not familiar with this ſcience, to add, in a parentheſis, the more uſual names of chemical ſubſtances; as for inſtance, to ſubjoin to *muriate of alumine* the common term of *alum*; and to *muriate of ſoda* that of *ſea-ſalt*. The Abbé has likewiſe uſed the term *caloric*, on all occaſions, inſtead of heat or warmth. In this the tranſlator has not judged it adviſable to follow him, except when he has employed it in the proper chemical ſenſe of the *matter of heat*.

The plates are faithful copies of thoſe in the original, but more careſully and elegantly finiſhed. Some may, perhaps, object to the diſproportionate ſize of the human figures repreſented in plates II. III. and V. This objection the author has foreſeen, and,

at

at the end of Vol. IV. apologizes, by remarking, that "the painter conceived he might be permitted this licence, as, had he attempted to obſerve the rules of proportion, theſe figures would have been ſcarcely diſcernible."

The work in the original is dedicated to Count Wilzeck, Imperial Plenipotentiary of the General Adminiſtration of Auſtrian Lombardy; but as this Dedication only contains the eulogiums of which ſuch compoſitions uſually conſiſt, it has been omitted.

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INTRO-

INTRODUCTION.

THE zeal with which I have always been animated to contribute, as much as might be in my power, to the improvement of the Public Imperial Muſeum of Natural Hiſtory in the Univerſity of Pavia, by enriching it with the new and important productions I procured in the various journeys and voyages I undertook both in Italy and other countries, incited me to travel, during the ſummer and autumn vacations, into the Two Sicilies. Though this Muſeum abounded in other kinds of natural productions, it was extremely de-

ficient in volcanic matters, which merely conſiſted of a few trivial ſcoriæ of Veſuvius, and ſome extremely common lavas of the ſame mountain, that having been cut into tablets and poliſhed had loſt their diſtinguiſhing characteriſtics, and conſequently could little contribute to the inſtruction of youth and the advancement of knowledge.

As I knew that no countries in Europe could furniſh a more ample and valuable collection of volcanic products than the Phlegrean Fields, Mount Etna, and the Eolian, or Lipari, Iſles; I reſolved to viſit them, and employed ſeveral months in laborious but uſeful reſearches. To make a proper choice, however, of the ſubſtances ſuitable to the deſign I had in view, it was neceſſary to examine on the ſpot the various qualities of the bodies compoſing thoſe volcanized regions. This I performed with

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the ſame diligence and care I have uſually exerted in the examination of other natural objects. Still more to enable myſelf to make this ſelection, and correct my judgment with reſpect to theſe ſubjects, I had read, and then re-peruſed, whatever had been written by travellers and the moſt eminent naturaliſts relative to volcanos, and was ſincerely grateful to them for the inſtruction I derived from their works. In the courſe of this enquiry, however, I diſcovered what I had often experienced before, with reſpect to other ſubjects, in which I had been preceded by other naturaliſts, that notwithſtanding the elegant and intereſting accounts they had given us of the countries which have ſuffered the action of fire, it was ſtill poſſible to add to them by my reſearches, and throw new light on volcanic knowledge. This I ſay not to arrogate to myſelf any merit, and ſtill leſs to

detract from that of others. The powers of the human mind are ſo limited, that it never can entirely exhauſt the ſubject it inveſtigates. Other naturaliſts who ſhall hereafter diligently explore the countries through which I travelled, it is not to be doubted, may improve this part of Natural Hiſtory with ſtill new diſcoveries. In like manner, though others have written of the Phlegrean Fields, Etna, and the Eolian Iſles, the obſervations I have made appear to me to merit publication.

The method in which I proſecuted my reſearches in theſe travels was the following: I have endeavoured to ſtudy volcanic countries as mountains ſhould be ſtudied. The lithologiſt who would acquire an accurate knowledge of the latter, attentively conſiders their ſtructure of rock, the whole of their huge maſſes, the poſition and direc-

tion

tion of the various parts or ſtrata which compoſe them, and the intertexture and relations of thoſe ſtrata. I have adopted the ſame mode of enquiry in the courſe of theſe travels. Fire in conjunction with elaſtic gaſes has formed whole mountains and iſlands; but all of them have not been produced in the ſame manner, nor are they compoſed of the ſame ſubſtance. Here we find large maſſes of tufa; there of ſcoriæ and lavas; in another part, pumices, enamels, and glaſſes; and in another a mixture of all theſe ſubſtances. It was therefore neceſſary to examine them on the ſpot, and obſerve, both when they were ſeparate and intermingled, their relations, directions, mixtures, &c. without once loſing ſight of the peculiar compoſition of theſe volcanic mountains, every part and receſs of which it was requiſite I ſhould explore.

In theſe enquiries I particularly directed my notice to two objects: the central ſummit of the iſlands and mountains, and their ſhores. The former is uſually the firſt ſenſible effect of the ſubterranean conflagrations, the part which firſt emerges from the waves, which often preſerves the crater entire, and ſometimes burning, but more frequently only its recognizable traces. The ſhores of volcanic iſlands and mountains bathed by the ſea, were alſo peculiarly entitled to attention, nor do I know that any volcaniſt who has hitherto travelled has made them one of the objects of his enquiry. We know how much it conduces to an accurate knowledge of the ſtructure of mountains, to croſs, or go round them in the beds of torrents which have corroded their foundations, and laid bare a part of their ſides; thus revealing, if I may uſe the

the expreſſion, their internal organization, which without this aid would have been ſought in vain from external appearances. The ſea, by inceſſantly beating with its furious waves the ſkirts of the iſlands, has cauſed fractures and ravages incomparably greater than thoſe occaſioned by rivers. By coaſting, therefore, theſe ſhores in a boat, landing where they appear to invite particular attention, and examining their open ſides, and rocks half fallen down and falling, we may obſerve a variety of important facts conducive to the improvement of that kind of ſcience. I ſhall not here enlarge on the advantages to be derived from coaſting volcanic iſlands; in the courſe of this work they will be proved by facts.

The reſearches I made in volcanic countries, though neceſſary, and highly inſtructive, were not, however, ſufficient to com-

plete my deſign. As lithologiſts are not ſatisfied with knowing the ſtructure, ſtratification, and other general qualities of mountains, but endeavour likewiſe to diſcover the nature of their component parts, I reſolved not to depart from the ſame method of enquiry. It is true that ſome volcanic productions are ſo altered by the fire, that it is difficult to aſcertain the nature of the earths from which they have been produced, unleſs we call in aid the proceſſes of chemiſtry. Such are enamels, glaſſes, and frequently pumices. But lavas, which, in the greater part of the places where I made my obſervations, are abundant beyond all belief, are ſeldom ſo changed by the fire as not to retain the evident characters of their primitive rocks.

I began, then, by conſidering the external appearance and qualities of the places I ex-

I examined, as far, at leaſt, as circumſtances would permit.

Whoever has undertaken to travel among mountains, in order to make reſearches relative to the foſſil kingdom, is not ignorant to what changes the ſurfaces of ſtony ſubſtances, even the moſt ſolid and hard, are ſubject, from the action of the elements during a long ſeries of years and ages. Hence, if he would form an accurate judgment of the ſtones he examines, he will not fix his attention on thoſe found on the ſurface of the earth, but rather on thoſe buried at ſome depth, and will frequently forcibly break and detach them from the internal maſſes of which they are a continuation. Still greater changes take place in ſome parts of the mountains which throw out fire, from the action of ſulphureous-acid vapours, beſides that of the atmoſphere

and of time; and very frequently the volcanic product, which on the ſurface ſeems to be of one kind, and at ſome depth of another, is in fact the ſame, but more or leſs changed in the firſt inſtance by the action of the atmoſphere, or that of ſulphureous vapours.

To render my reſearches more accurate and certain, it was neceſſary that I ſhould not content myſelf with a ſingle inſpection of the volcanic ſubſtances, on the ſpot where I gathered them. I therefore, when I returned to Pavia, re-examined them with the greateſt care, in the retirement of my ſtudy; not only with the naked eye, but with the aid of the lens, before I began to characterize and deſcribe them lithologically. The reader will find ſome of the deſcriptions rather diffuſe; and, perhaps, I may be charged with having been too minute.

But it appeared to me that I could not be more concise; as a detailed deſcription of ſuch products can alone enable us to diſcover to what kind of rocks they appertain, and what is the particular characteriſtic of the volcanic countries in which they are found. Thoſe who, when treating of volcanos, have been ſparing of ſuch deſcriptions, have left us imperfect works, though in other reſpects they may be very valuable. All who are verſed in theſe ſubjects, are acquainted with the account of the famous eruption of Etna in 1669, and the memoirs relative to different remarkable conflagrations of Veſuvius by Serao, Della Torre, Sir William Hamilton, and Bottis. With reſpect to what regards the currents of lava which thoſe two volcanos at thoſe times poured forth, the ſymptoms and phenomena that accompanied them, and the other circumſtances deſerving notice which preceded

preceded and followed them, their hiſtories certainly merit great commendation. They will be highly valuable in the eſtimation of every lover of volcanic ſcience; and I have frequently, in the courſe of this work, derived ſuch aſſiſtance from them as demands my grateful acknowledgment. But from theſe relations, what idea can we in general form of the nature of the products ejected and the currents they have formed? When do they deſcribe with ſufficient accuracy a ſingle ſubſtance? After having read theſe relations of the violent eruptions which have burſt from the ſides of Veſuvius and Etna, we remain profoundly ignorant to what primitive rocks they appertain. I mean not by theſe remarks to injure the reputation theſe writers have juſtly acquired. Their deficiency in lithological ſtudies, not cultivated at that time as in the preſent, is a ſufficient excuſe; I intend only to ſhew the neceſſity

neceſſity there is for circumſtantial deſcriptions, which, in fact, form the baſis of all ſolid ſcience.

It is neceſſary that I ſhould here mention, with reſpect to the deſcriptions I have given of the different products of the various volcanic places I viſited, that, though I have treated diffuſely, and in detail, of thoſe of the Phlegrean Fields, ſituated to the weſt of Naples, and of others of the Eolian or Lipari Iſles; I have only ſpoken incidentally of the productions of Veſuvius and Etna, though both theſe volcanos have furniſhed me with a great number of ſpecimens for the Muſeum at Pavia; not only becauſe that to have examined theſe two mountains minutely, would have required years inſtead of a few months; but becauſe a deſcription of theſe has already been executed with great ability by the Chevalier Gioeni, in his *Lithologia*

Lithologia Veſuviana, and by M. Dolomieu, in his "Deſcriptive Catalogue of the Pro-"ducts of Etna."

The opportunity afforded me by having theſe volcanic ſubſtances continually under my inſpection at Pavia, induced me to make new experiments on them. It is certain, that the greater part of them contain iron. Yet the proof of this by experiment was not ſuperfluous, as the greater or leſs quantity of the martial principle might thus be diſcovered. I therefore uſed, according to circumſtances, the magnetic needle, or magnetized knife. I applied the former to the products reduced to powder, and the latter to thoſe in fragments; taking care that they ſhould always be, as far as I was able to effect it, of the ſame conſiſtence and volume. I then obſerved the different diſtances at which they attracted the magnetic needle,

needle, without noticing the pieces which exerted no ſuch power, though I do not mean by that to deny that they contained iron*.

I was attentive at the ſame time to an enquiry of much greater importance. Veſuvius, Etna, the Eolian Iſles, and Iſchia, are large mountains formed of rocks which have undergone liquefaction, and ſometimes a true vitrification; ſuch has been the violence of the ſubterranean conflagrations. What fire can we produce equivalent to theſe effects? I have diſcovered that the fire of the glaſs-furnace will completely refuſe the vitrifications, enamels, pumices, ſcoriæ, and lavas of theſe and other volcanic countries. The ſame will, in like manner, vitrify rocks con-

* As the iron is ſometimes in the ſtate of oxyde (calx), I employed the uſual methods to revive it in the productions I examined.

generous

generous to thoſe from which theſe mountains have originated by the means of ſubterranean conflagrations. A leſs intenſe fire, on the contrary, produces no ſuch effect on any of theſe ſubſtances.

As I wiſhed to attain to the moſt rigorous accuracy in this experiment, I was not ſatisfied with diſcovering that the fire of the glaſs-furnace was capable of effecting theſe fuſions; I determined, if poſſible, to aſcertain the preciſe degree of heat neceſſary to produce them, for which purpoſe nothing could be better adapted than the pyrometer of Wedgwood. This inſtrument, it is well known, is compoſed of two parts; the thermometric pieces and the gage. The former are ſmall cylinders of very fine clay. The latter, which is ſix inches long, is formed by two pieces of the ſame earth, the internal ſides of which are ſtraight and ſmooth,

ſmooth; but ſo diſpoſed as to be more diſtant from each other at one extremity than the other, thus forming a converging ſpace divided into 240 parts. The greater aperture of this gage is the beginning of the ſcale, and denotes the heat which produces a beginning of redneſs in iron. If, therefore, one of the clay cylinders ſhall have been expoſed to a greater heat, it will be contracted, and ſink lower between the converging ſides; and, the ſides being graduated, the degree at which it ſtops will be the meaſure of its contraction, and conſequently of the degree of heat it has undergone; the cylinders, as the inventor has obſerved, repreſenting the mercury, and the converging ſides the ſcale of the thermometer.

To aſcertain, therefore, the degree of heat in the glaſs furnace neceſſary for the fuſion of theſe volcanic productions, and the rocks

whence they derive their origin, I made uſe of this pyrometer in the following manner. I placed in the furnace, near the ſubſtances I intended to fuſe, one or more of the clay cylinders abovementioned, in a caſe of the ſame clay, and let them remain there the whole time neceſſary for the fuſion of thoſe ſubſtances. I then meaſured their contraction by the gage; and found that the heat of the glaſs furnace was $87\frac{1}{8}$ degrees of this pyrometer; a heat, according to the obſervation of the inventor, but $2\frac{1}{2}$ degrees leſs than that of welding iron, which latter heat correſponds to 12777° of Fahrenheit's thermometer*. In fact, filings of iron (in which the ſurface of the metal is greatly enlarged) being continued four-and-twenty hours in the glaſs furnaces of Pavia, of which I always made uſe in theſe experiments, conglutinated into a ſolid though friable

* Journal de Rozier, tom. xxx.

body,

body, and ſhewed an evident beginning fuſion. Whence I conclude that a greater heat is uſually kept up in theſe furnaces than is neceſſary for the fuſion of glaſs.

Though the blowing pipe did not in general greatly conduce to the ſucceſs of my experiments, I ſometimes found it uſeful. In ſome caſes I likewiſe had recourſe to the aſſiſtance of fire excited by oxygenous gas (dephlogiſticated air).

There is ſcarcely any natural product, volcanic or not volcanic, of which I have treated in this work, that I did not try in the fire, in one or other of the manners I have deſcribed, and frequently more than once. Theſe experiments in the dry way I often accompanied with others in the humid, with reſpect to the productions of volcanic fire.

The manner in which I proceeded was as follows:

When the external appearance of theſe products perfectly agreed with that of earths not volcanic before known, and analyſed by able chemiſts; I thought I might determine the genus of the volcanic production without analyzing it in the humid way; and when I made experiments on a few pieces, I found I was not deceived. But when the external appearance appeared to me new, and not to agree with that of the earths already known, I then had recourſe to an examination by the humid method, by which I elucidated the genus, and frequently the ſpecies, of theſe ſubſtances. Before, therefore, I proceeded to deſcribe any pieces I had collected, I was certain, or thought myſelf ſo, that I had obtained a ſufficient knowledge of them. And when I could

I could not arrive at this knowldge, but remained uncertain to what genus they appertained, I have never failed to expreſs myſelf doubtfully. In theſe reſearches, equally laborious, delicate, and neceſſary, I have employed much of my time, not without conſiderable expence. In my volcanic travels I have been obliged to take upon myſelf the parts both of naturaliſt and chemiſt. The natural hiſtory of foſſils is ſo cloſely connected with modern chemiſtry, and the rapid and prodigious progreſs of the one ſo exactly keeps pace with that of the other, that we cannot ſeparate them without great injury to both. But as the chemiſt in his laboratory can reaſon but imperfectly concerning the mountains, the component earth of which he analyzes; ſo the obſervations of the lithological traveller muſt always be defective when not conjoined (at leaſt when it may be neceſſary) with chemical inveſtiga-

tions. What is true of foſſils not volcanic, muſt likewiſe be ſo, in a certain degree, and with neceſſary allowances, of volcanic foſſils. Here, in fine, neither obſervation alone, nor experience alone, are ſufficient; but both muſt join to conduct the inveſtigator of nature, or he cannot be ſucceſsful in his reſearches.

Where my experimental enquiries have been ſhort, I have incorporated them with my narrative; as they are relative to the productions I met with in the different places I viſited. But more than once I have found it convenient to act otherwiſe; and the ſubjects treated, appear to me to juſtify the method I have adopted.

What is the activity, in general, of volcanic fires, has been a queſtion long agitated, and which is certainly of difficult ſolution.

In

In this diſpute, writers have gone into oppoſite extremes; ſome aſſerting that theſe fires are extremely active, and others that they are very feeble, while all endeavour to ſupport their opinions by facts. Having treated on volcanos ſo much at length in this work, I could not avoid conſidering this queſtion. I have weighed the arguments on both ſides without prejudice; I have made various experiments; and declared in favour of the opinion which appeared to me to have the ſtrongeſt ſupport from reaſon and from facts.

The nature of elaſtic gaſes by which the liquefied matters of volcanos are penetrated and agitated, was another ſubject well deſerving attentive conſideration. The vacuities, inflations, and tumors, which ſuch matters frequently retain in a ſtate of congelation, can only be aſcribed to the elaſticity of theſe gaſes while they were in a ſtate of li-

quidity. Our common fire will reproduce in them theſe gaſes equally with the volcanic. In fact, many lavas, pumices, glaſſes, enamels, and ſcoriæ, though by pulverization they may be deprived of theſe vacuities, which are more or leſs large, and uſually orbicular, recover them by refuſion in the furnace; and in many of theſe bodies the gaſeous bubbles are ſo abundant, that by their great inflation, while in actual fuſion, they force them to flow over the edges of the crucible. Theſe obſervations led the way to enquiries relative to the qualities of theſe gaſes, by liquefying in chemical furnaces volcanic ſubſtances reduced to powder, and placed in matraſſes fitted to a chemical mercurial apparatus. By a great number of experiments of this kind I diſcovered the true nature of theſe gaſeous ſubſtances, of which our knowledge was before very vague and uncertain.

This

This diſcovery naturally led to the enquiry what part the elaſtic gaſes take in the eruptions of volcanos; and this enquiry to a diſcuſſion of the cauſes of thoſe eruptions.

The chemical proceſſes I employed to aſcertain the characters of the gaſes of volcanic productions likewiſe diſcovered to me a new fact, which was, that ſeveral of theſe productions contain muriatic acid. This diſcovery again produced new enquiries*.

Laſtly, I muſt not omit the reſearches relative to the origin of priſmatic or baſaltiform lavas. It is an opinion almoſt univerſal, that lavas take this regular figure in the ſea,

* In theſe chemical experiments I was greatly aſſiſted by the Signors Nocetti, father and ſon; the former operator in the public ſchool of chemiſtry in Pavia, and the latter repeater in the ſame. They are both well verſed in chemical ſcience, and are entitled to my grateful acknowledgments.

by

by the ſudden condenſation and congelation they ſuffered when they flowed into it in a fluid ſtate. I could not have met with examples of this kind more proper to enable me to form a judgment on the ſubject than thoſe which preſented themſelves to my view while coaſting the ſhores of Italy, a great part of Etna, and the whole of the Lipari iſlands.

Theſe different diſcuſſions relative to the efficacy of ſubterraneous conflagrations, the gaſes of volcanic productions, the cauſes of the eruptions of volcanos, and the muriatic acid contained in various of their products; with the enquiries concerning the origin of baſaltiform lavas—to treat them at length, as they required, would have too much broken the thread of the narrative of my travels. I have therefore placed them in ſuch a manner as not to interfere with

with my accounts of the Phlegrean Fields, Etna, and the Eolian Iſles.

In the volcanized countries in which I travelled, there are four craters ſtill burning, Veſuvius, Etna, Stromboli, and Vulcano. To all theſe four, from an ardent deſire of obtaining knowledge, I wiſhed to make a near approach. By Veſuvius this wiſh was not gratified; but Etna was more condeſcending, though incomparably more formidable; and a ſimilar good fortune attended me at Stromboli and Vulcano. The clear and diſtinct view I had of theſe three craters was equally pleaſing and inſtructive. The crater of Etna I delineated myſelf; the views of Vulcano and Stromboli are the work of a draughtſman I took with me for that purpoſe, and who likewiſe furniſhed me with drawings of ſome other volcanic mountains deſcribed in this work. I ſhall only add, that

that all theſe deſigns have been retouched and greatly improved by Sig. Franceſco Lanfranchi, an eminent painter in the Univerſity of Pavia.

The origin of the Lipari iſlands, which are the productions of fire, was certainly the principal motive of my viſiting them; yet in many other reſpects they are certainly very intereſting. The character, manners, and cuſtoms of the inhabitants; their population, agriculture, and commerce, are objects well deſerving enquiry; and have the greater claim to the attention of an Italian, from their being ſo little known in Italy.

I have alſo made ſome obſervations on the animals in thoſe iſlands, as, for inſtance, on a kind of birds, which, with us, are birds of paſſage, but there (in part at leaſt) ſtationary:

ary: I mean ſwallows. Some years ago I made obſervations on the natural qualities of ſeveral ſpecies of ſwallows (the *Hirundo ruſtica, urbica, riparia, apus, melba, Linn.*) and to theſe I now add thoſe I made in the Lipari iſlands.

The environs of Meſſina, where, after I had finiſhed my volcanic travels, I remained more than a month, afforded me much inſtruction from the variety of natural objects they preſented. Though four years and a half had elapſed ſince that unfortunate city had been laid in ruins by earthquakes, the melancholy ſcene was ſtill freſh in every one's memory. A great part of the public and private edifices were ſtill in the ſame ruinous condition to which they were reduced by that calamitous event. Numbers of the inhabitants ſtill continued to lodge in the half deſtroyed houſes, and others in huts

and

and ſheds; while they all appeared oppreſſed and overwhelmed with fears from which they had not yet recovered. The impreſſions made on me by what I ſaw of the effects of this calamity were ſuch that I could not refrain from giving a brief account of the melancholy ſituation in which I found Meſſina, and of the deſtruction occaſioned by the dreadful earthquake in 1783.

Scylla and Charybdis, the former diſtant twelve miles from Meſſina, and the latter about a hundred paces, within the famous Strait, were two objects to which I firſt turned my attention. That part of the ſea being then calm, at leaſt as calm as the Strait of Meſſina can be; I was enabled to take a near view of them both, and even to paſs over Charybdis in a boat. I alſo made enquiries of the Meſſineſe ſailors, who are employed the greater part of the year in

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that Strait, and conſequently have an opportunity of forming a juſt and preciſe idea of theſe two celebrated places; and from what they told me, and the obſervations I made myſelf, I am convinced that Charybdis is not a real whirlpool, as has been hitherto believed.

In the Strait of Meſſina I found other inſtructive natural curioſities furniſhed by the fiſheries for the ſword-fiſh *(Xiphias gladius Lin.)*, the ravenous ſhark *(Squalus carcharias)*, and for coral *(Iſis nobilis)*.

Being at Meſſina at the time of the annual paſſage of the ſword-fiſh through the Strait, I was preſent at the fiſhery, which appeared to merit ſome deſcription from the ſingular form of the veſſels employed in it; the method of ſtriking and taking the fiſh; and the qualities and periodical migrations

grations of the animal. I have, likewiſe, made ſome obſervations on ſome fiſh of the genus of the *ſqualus*, particularly the ſhark, ſometimes ſo dangerous to fiſhermen in that ſea.

Coral, for which the Meſſineſe mariners fiſh the whole year, by tearing it with nets ſuitable to the purpoſe from the rocks at the bottom of their Strait, has been long an ambiguous production, and made to paſs through all the three kingdoms of nature; ſome conſidering it as a foſſil, others as a vegetable; until, at length, it has been proved to appertain to the cluſs of animals, though it has the appearance of a plant; and is, therefore, now properly claſſed among the zoophyta. The excellent obſervations of Peyſſonel and Vitalianio Donati are well known; nor ought Marſigli to be denied the praiſe his merits,

though a zealous maintainer that coral is a plant. Notwithſtanding, however, theſe great diſcoveries, much was wanting to a complete hiſtory of this noble zoophyte, to which, I flatter myſelf, I have in ſome ſmall degree contributed by the obſervations I made on it, at the time of the fiſhery, at which I was preſent.

On this occaſion, while the fiſhermen were throwing the net for the coral, I employed myſelf in reſearches for marine animalcula. I carefully examined every piece of a ſtalk, leaf, or other fragment of a marine plant, or any thing elſe which hung to the net, having learned from experience that theſe ſubſtances ſometimes contain wonders, in the claſs of animated beings; for, as Pliny has wiſely remarked: Nature is greateſt in her leaſt productions. When the fiſhermen, therefore, turned up their

nets to free them from the weeds which were mixed with the coral, I put theſe weeds into glaſs veſſels, filled with ſea-water, to obſerve the animals adhering to them, and ſelect thoſe which appeared to preſent any remarkable novelty. Several of theſe were not wanting; of the genera of the *Aſcidiæ* and the *Eſcharæ*. I likewiſe diſcovered ſome ſmall polypi, in which I could diſtinctly ſee the circulation of the fluids; which has not, to my knowledge, been before obſerved in theſe minute animals. The deſcription I have given of them is accompanied with the neceſſary figures.

The ſurface, likewiſe, of the Strait of Meſſina was equally favourable to my reſearches with the bottom. In other parts of the Mediterranean, the Adriatic, the Archipelago, and the Strait of Conſtantinople,

naple, I had examined ſeveral ſpecies of thoſe molluſca which are commonly called meduſæ. I had admired the ſimplicity of their organization, and eſpecially that property by which certain ſpecies of them, of the weight of twenty pounds or more, diſſolve almoſt entirely into a liquor; nothing remaining of them but ſome thin and dry pellicles, which are only a few grains in weight. I had never however met with any of that phoſphoreſcent kind which Lœflingius tells us he ſaw in the ocean between Spain and America. The mention he has thus made of them, without adding any further obſervations, can only ſerve to excite the curioſity of the reader; nor do I know that any other author has deſcribed this rare animal. In the Strait of Meſſina I had the pleaſure to find abundance of theſe phoſphoreſcent molluſca, and the [illegible] I made in that city afforded me an opportunity to examine their or-

 ganization,

ganization, their motion, and the beautiful light they emit in the dark.

I concluded my reſearches relative to the natural objects in the vicinity of Meſſina, by examining the ſhore, hills, and mountains, which on the ſide oppoſite the ſea look toward that city. I could diſcover no ſign of volcanization; but I obſerved, firſt, immenſe maſſes of teſtaceous and other animals petrified, the ſpecies of which were perfectly diſtinguiſhable. Secondly, granite, which probably is a continuation of that of Melazzo, diſtant from Meſſina thirty miles to the north; and with reſpect to which I endeavoured to aſcertain whether it formed ſtrata, as ſome ſuppoſe, or only great maſſes, as is the opinion of others; as alſo whether it contained within it petrified marine bodies, as has been conjectured. Thirdly, ſandſtone, which, it appears to me probable, forms,

forms, in a great meaſure, the bottom of the Strait of Meſſina, extending to the point Peloro, and being reproduced by a petrifying principle. We ſhall ſee that by means of this principle, human ſkeletons, and other extraneous bodies, are ſometimes found included in it; and that, in conſequence of the ſame, at the part near Peloro, where the Strait is narroweſt, it is probable that Sicily, loſing the name of an iſland, will one day be again joined to Italy.

Having made the circuit of the Phlegrean Fields, the Eolian Iſles and Etna, the principal objects of my travels, I returned to Pavia, going by ſea from Naples, without the leaſt thought of making any new obſervations. But the lake of Orbitello, celebrated for the immenſe quantities of large eels (*Muræna Anguilla Linn.*) it produces, became a new incentive to my curioſity;

and a dead calm detaining the veſſel in which I had taken my paſſage ſeveral days at Porto Ercole, a few miles diſtant from Orbitello; as I could eaſily obtain as many eels as I choſe, I examined them with great attention to diſcover, if poſſible, the manner in which they propagate their ſpecies, ſince, notwithſtanding the numerous experiments that have been made both by ancient and modern naturaliſts to elucidate this queſtion, it is not yet known with certainty whether they are viviparous or oviparous. To the experiments I now made, when I returned into Lombardy, I added many others in the following years, made in every ſeaſon.

With this view, expreſsly, I repaired to the lakes of Comacchio, which, with that abovementioned, abound more with this fiſh than any in Europe. Here aſſiduouſly ſtudied the various qualities of the animal, in

order to illuſtrate its hiſtory, which is in many reſpects deficient and obſcure.

The laſt place at which I landed before my arrival at Genoa, was the iſland of Elba, where I was obliged to remain five days in conſequence of another calm. I profited by this delay to viſit the ancient and celebrated iron mines, where I procured for the Imperial Muſeum at Pavia ſome noble ſpecimens of that metal cryſtallized, and augmented the copious collection I carried with me with ſome ſulphures of iron (pyrites).

I returned to the Univerſity about the end of the year 1788, having employed ſix months in my travels in the two Sicilies; with which, though they were at my own expence, like the greater part of my other travels, I am well ſatisfied, ſince I have been able to contribute ſomething to that noble

public inſtitution the Muſeum at Pavia; but my ſatisfaction will be ſtill greater, if the work I now preſent to the public be approved by its readers.

Thus I employed the ſummer and autumnal vacations of that year. Some time before, but eſpecially in the vacations of 1789 and 1790, I made reſearches among the mountains of Modena and Reggio, with reſpect to objects which, as they have a relation to volcanos, may have a place in this work.

The fires of Barigazzo, which burn on the Apennines of Modena, have been long known. Theſe conſiſt of groups of feeble flames collected in a narrow ſpace, which riſe above the earth, are almoſt always viſible, and, if by chance they become extinct, may be rekindled by bringing a ſmall flame to the ſpot where they were. The

accounts

accounts of them, however, are ſo few, and ſo defective, that, at moſt, they can only ſerve to compare the preſent ſtate of theſe flames with what it once was. The light afforded by modern phyſics enables us to affirm, without farther examination, that the cauſe of this feeble fire muſt be hydrogenous gas (or inflammable gas). I made a journey to Barigazzo purpoſely to aſcertain this, and found it to be the fact. In that vicinity there are ſix other ſimilar fires, at preſent only known to the Alpine peaſants, all originating from the ſame principle.

But in the preſent accurate ſtate of our knowledge relative to aëriform gaſes, it is too little to ſay and prove that the cauſe of theſe various flames is hydrogenous gas. The following are the principal enquiries which I think neceſſary for me, as a naturaliſt, to make with reſpect to theſe fires,

and

and ſuch objects as may have a relation to them.

Firſt, to examine the ſtructure and compoſition of thoſe mountains; and here I ſhall incidentally have occaſion to ſpeak of *Cimone*, not far diſtant from Barigazzo, and the higheſt mountain of our Apennines.

Secondly, carefully to remark the qualities of each of theſe fires, and the phenomena accompanying them.

Thirdly, to compare theſe fires nouriſhed by natural hydrogenous gas, with thoſe produced by hydrogenous gas procured by art.

Fourthly, to make a rigorous analyſis of the hydrogenous gas of the fires of Barigazzo and the other neighbouring places,

by

by means of the chemical mercurial apparatus; and to carry to thoſe Alpine heights veſſels to contain the different aëriform fluids, and inſtruments neceſſary for theſe analyſes.

Fifthly, to make the ſame analyſis of the earths from which theſe fires ariſe. And here I muſt obſerve by the way, that having made at Barigazzo an excavation of ſome depth and ſize, in order to obtain the earth pure; the fires multiplied ſo much, and became ſo powerful, that, after I had left the place, the hollow was employed as a furnace for lime, and lime-ſtone as perfectly burnt in it as in furnaces prepared for the purpoſe.

Sixthly, to examine what may be the matters generative of this inexhauſtible ſupply of hydrogenous gas; which has been ſo long continually developed; it being certain,

certain, from authentic documents, that theſe fires have burned for a century and a half.

In the hills of Modena and Reggio we find certain places which the people of the country call *Salſe*, and which are a kind of volcanos in miniature; having the form externally of the truncated cone, and, internally, of the inverted funnel. They ſometimes throw up into the air earthy matters; which at other times overflow, and, pouring down their ſides, form ſmall currents. After the manner of burning mountains, they frequently open with ſeveral mouths; and like them rage, thunder, and cauſe ſlight earthquakes around them. But in the true volcanos the primary agent is fire; in theſe *Salſe* the generative principle is entirely different.

Some

Some of them have hitherto remained wholly unknown to naturaliſts: of others authors have written, but have deſcribed the phenomena with little accuracy and frequent exaggeration; not to mention that, at the time when they wrote, the nature of the agent from which theſe phenomena derive their origin was not diſcovered.

Theſe *Salſe* have claimed my attention equally with the fires abovementioned; and I have applied myſelf to ſtudy them with equal aſſiduity, and with the ſame chemical analyſis; and as they both, after the manner of volcanos, undergo changes which appear ſometimes to have relation to thoſe of the atmoſphere, I have judged it neceſſary frequently to viſit them, and in different ſeaſons, to obſerve the various phenomena, and with more certainty diſcover the ſecret cauſes to which they owe their origin.

The Travels I now preſent to the public, and of which I have here given the ſummary, will be ſpeedily followed by another work containing an account of my voyages to Conſtantinople, in the Mediterranean, and in the Adriatic.

ERRATA.

VOL. I.

Page	Line	
46	20	*after* paonazzo, *read*, or purple colour.
—	22	*for* vitrifactions *read* vitrifications.
58	10	*for* oxyde of yellow iron *read* yellow oxyde of iron.
124	15	*for* ſmalt *read* enamel.
163	11	*dele.* other.
174	23	*for* native iron *read* ſpecular iron.

VOL. II.

65	13	*for* the lava *read* as the lava.
209	16	*for* likewiſe ſuffered *read* likewiſe had ſuffered.

VOL. III.

306	2	*dele* of.

A The highest Mouth.
B Monte Formiano.
C Schiena del Asino (the Asse's back)
D Serra Pizzuto.
E Fondaco del Defeso.
F Pelata.
G Mompileri.
H Nicolosi.
I Guardia.
L Mal passo.
M Campo Rotondo.
N San Pietro.
O Mister dianco.
P San Giovanni di Galermo.
Q Phichi.
R Mascalucia.
S Trimisteri.
T Catania.
V Cleft 10 Miles in length.
X Depression of the Summit.
Y Extreme Promontory della Sciara.
Z Fuming Aperture remaining after the extinction of the conflagration.

TRAVELS

IN THE

TWO SICILIES, &c.

CHAP. I.

A VISIT TO VESUVIUS DURING THE TIME OF AN ERUPTION.

Little notice taken by the Neapolitans of the ſmaller eruptions of this volcano—Phenomena obſerved by the author on his arrival at Naples—His approach near to the crater prevented by ſhowers of ignited ſtones, and acid-ſulphureous fumes—Extraordinary phenomenon relative to theſe ſhowers—Explication of that phenomenon—Remarks on the congelation of a torrent

of lava—Obſervations on a ſtream of lava flowing within a cavern—Projected experiment for meaſuring the quantity of heat in the flowing lava—Other obſervations on the lava iſſuing from a ſubterraneous cavity—Remarkable cataract formed by it in its paſſage—Length, breadth, and termination of this torrent—Phenomena of this eruption of Veſuvius compared with thoſe of preceding ones—Erroneous opinion of ſome naturaliſts, that the lava is not fluid, but of the conſiſtence of paſte—Compoſition of this lava—Obſervations on a lava of Viſuvius which flowed in 1785—Proofs that the ſhoerls and feldſpars found in the lava exiſted previouſly in the primordial rocks.

WHEN I arrived at Naples, on the 24th of July 1788, though Veſuvius was not in a ſtate of inactivity, its conflagration was not ſufficient to excite the curioſity of the Neapolitans; who, from having it continually before their eyes, are ſeldom inclined to viſit it, but during its great and deſtructive eruptions,

tions. At that time, during the day, it without intermiſſion ſent forth ſmoke, which riſing formed a white cloud round the ſummit, and, being driven by the north-eaſt wind, extended in a long ſtream to the iſland of Capri. By night, repeated eruptions of fire were viſible, though no ſubterraneous exploſions were to be heard at Naples; and a tract of ground to the ſouth of the crater aſſumed a duſky red colour, which, by the experienced in volcanic phenomena, was ſaid to be preparatory to the flowing of the lava. I ſhould immediately have repaired to the place, had not my friends at Naples aſſured me, from the practical knowledge they had of their burning mountain, that that eruption, which at my arrival was but inconſiderable, would after ſome time become much more extenſive. It was in fact my wiſh to ſee Veſuvius, if not raging with its moſt tremendous fury, at leaſt in a more than ordinary commotion.

I, in conſequence, returned from Sicily to Naples in the beginning of November, when

a ſtream of lava, iſſuing from an aperture in the ſide of the mountain, covered a conſiderable extent of ground, and began to be viſible before day-light, from beyond Capri, under the appearance of a ſtreak of a reddiſh colour. On the 4th of the ſame month, I began my journey to the volcano, and paſſed the night at the Hermitage del Salvatore, two miles from the ſummit of the mountain. Before I retired to reſt, I paſſed ſeveral hours in making obſervations with the greateſt attention; nor could the opportunity have been more favourable, as there was no moon, and the ſky was perfectly free from clouds.

I had therefore a clear view of the eruptions of the mountain, which had the appearance of a red flame, that enlarged as it roſe, continued a few ſeconds, and then diſappeared. The ejections ſucceeded each other at unequal intervals of time; but no intermiſſion continued longer than five minutes.

I roſe

I roſe four hours before day, and continued my journey towards the burning crater, from which, as I have before ſaid, flames aroſe at intervals, which on a nearer approach appeared larger and more vivid; and every ejection was followed by a detonation, more or leſs loud, according to the quantity of burning matter ejected: a circumſtance I did not notice before, on account of the diſtance, but which became more perceptible to the ear in proportion as I approached the mouth of the volcano; and I obſerved, when I had arrived within half a mile of it, in a direct line, that the ejections preceded their accompanying exploſions only by an inſtant, which is agreeable to the laws of the propagation of light and ſound. At this diſtance not only flames were viſible to the eye, but a ſhower of ignited ſtones, which, in the ſtronger ejections, were thrown to a prodigious height, and thence fell on the declivities of the mountain, emitting a great quantity of vivid ſparks, and bounding and rolling till they came within a ſhort diſtance of the place where I ſtood.

Theſe ſtones, when I afterwards examined them, I found to be only particles of the lava, which had become ſolid in the air, and taken a globoſe form. Theſe ſhowers of lava appeared an invincible obſtacle to my nearer approach to the volcanic furnace. I did not, however, loſe all hope, being encouraged by the following obſervation. The ſhowers of heated ſtones, I remarked, did not fall vertically, but all inclined a little to the weſt. I therefore removed to the eaſt ſide of Veſuvius, where I could approach nearer to the burning mouth: but a wind ſuddenly ſpringing up from the weſt, compelled me to remove, with no little regret, to a greater diſtance, as the ſmoke from the mouth of the crater, which before roſe in a perpendicular column, was now drifted by the wind to the ſide on which I ſtood; ſo that I ſoon found myſelf enveloped in a cloud of ſmoke abounding with ſulphureous vapours, and was obliged haſtily to retire down the ſide of the mountain. Yet though I was thus diſappointed of the pleaſure of approaching nearer to the edge of the crater,

and

and obſerving the eruptions more nearly and accurately, many inſtructive objects were not wanting. But before I proceed to any remarks on theſe, I muſt notice a curious and unexpected circumſtance.

I have already ſpoken of the detonations which accompanied the ſhowers of lava. It is now neceſſary to add, that theſe did not conſtantly accompany every eruption. When I had taken my ſtation in the lower part of the mountain, I found the detonations more ſenſible, and reſembling the noiſe produced by a large mine when it explodes; but ſuddenly, to my great ſurpriſe, they ceaſed, though the ejections of fiery matter continued both frequent and copious. I counted eighteen eruptions which were not accompanied by the ſmalleſt noiſe. The nineteenth, though not larger than the former, was followed by its detonation, as were eleven more, though others which ſucceeded were ſilent. This irregularity I obſerved ſo repeatedly, that the detonations appeared to me rather accidental than neceſſarily

ceſſarily connected with the exploſions. In this opinion I am ſupported by the authority of my ingenious friend, the Abbé Fortis, who afterwards told me, at Naples, that he had frequently obſerved the ſame inconſtancy in the eruptions of Veſuvius.

This peculiar phenomenon, which has not, to my knowledge, been remarked by any one of the numerous authors who have written on Veſuvius, does not appear, at firſt view, to be eaſily explicable from the phyſical cauſe of the exploſions. As it muſt be allowed that the fire alone is not ſufficient to produce it, we muſt have recourſe to an elaſtic fluid, which diſengages itſelf from the lava, impelling at the ſame time a part of it into the air; which effect can ſcarcely happen without a detonation. But on more mature reflection it appeared to me moſt probable that this takes place only within certain limits. When the elaſtic fluid burſts ſuddenly againſt the lava, it is to be expected that it will produce a conſiderable report; but when it acts ſlowly it will occaſion little or

none,

none, though the ejection may be very ſtrong. Thus, if the atmoſpheric air be confined between two pellets of tow in a tube, and one of them be forced ſuddenly towards the other, the latter will be projected to ſome diſtance, with a conſiderable ſound, but none, or very little, will be heard if the pellet be gradually preſſed towards the other. In like manner, the air contained in an air-gun produces ſcarcely any report on its diſcharge, on account of the interpoſition of the valve delaying its action on the ball.

In what I have ſaid, however, I do not mean to aſſert that theſe volcanic eruptions were entirely unaccompanied with any explosive ſound. It is highly probable they were not; but that I could not hear the feebler detonations on account of the diſtance.

It has been already ſaid, that the liquid lava had opened itſelf a way, not immediately from the ſummit of the crater, but from one ſide of the mountain. The following

lowing are the obſervations made on this ſubject. Towards the ſouth-eaſt, at the diſtance of about half a mile from the crater, on a declivity, there aroſe ſixty or more ſmall columns of ſmoke, one of which was about nine feet in diameter, and came from a not very deep cavern. The ground from which theſe ſtreams of ſmoke iſſued was tinged with yellow, from the muriate of ammoniac, and ſo hot, that, even at ſome diſtance, I could bear my feet on it only for a few ſeconds. It is ſufficiently manifeſt that the ſmoke and the heat proceeded from the ſame cauſe; that is to ſay, from the ſubterraneous conflagration which communicated with that part, and cauſed the ſmoke to burſt forth through the fiſſures in the ground.

At the diſtance of a few paces from this ſpot, the aperture was viſible through which, ſix months before, the lava diſgorged itſelf, as I was aſſured by my guide; but it no longer flowed at the time of my arrival, its current having acquired the hardneſs of ſtone.

ſtone. About fifty paces lower, however, in the ſame direction, that is towards the ſouth, the lava was ſtill running within a kind of pit, but without riſing above its borders; and at a place ſtill lower, about two miles from the principal crater of Veſuvius, the lava iſſued from the ſubterranean cavern, forming in the open air a long current. But before I proceed to deſcribe the latter, it will be proper to notice the highly curious phenomena obſervable in the lava moving within the above-mentioned cavity or pit. This pit was of a ſhape approaching to an oval, about twenty-three feet in circuit. The ſides, or banks, were nearly perpendicular, about four feet and a half in height; and it was excavated in the hardened lava of the laſt eruption. The burning lava moved within this cavern, of which it covered the whole bottom, in the direction of from north to ſouth. From it aroſe a cloud of ſmoke, which, reflecting the light from the red hot lava, produced in the air a red brightneſs, that during the night might be ſeen at a conſiderable diſtance. But as this ſmoke

was

was ſtrongly impregnated with acid-ſulphureous vapours, I found it a great obſtacle to my making any obſervations on the liquid lava, when, from the calmneſs of the air, it aſcended perpendicularly. But, from time to time, a ſlight breeze aroſe which carried the ſtream towards one ſide; and I then removed to the oppoſite, where I was no longer incommoded in my experiments by the vapour. During theſe favourable intervals, I could ſtoop down towards the pit, in which I obſerved the appearances which I here faithfully relate.

As the diſtance between the lower extremities of my body and the lava was only five feet, the heat it ſent forth was very vehement; but not abſolutely intolerable, though it forced me to remove from it a little, from time to time.

I obſerved, then, that the lava flowed, as I have before ſaid, along this cavity, from the north to the ſouth, and then diſappeared under the excavated hardened lava. Its

ſurface

ſurface exhibited the redneſs of burning coal, but without the ſmalleſt appearance of flame. I know nothing to which it can be more properly compared than melted braſs in a furnace. This ſuperficies was in ſome places covered with a white froth; and from time to time bubbles aroſe in it, which burſt a moment after with a ſenſible noiſe. Sometimes, likewiſe, the lava roſe in ſmall jets or ſpouts, which, in an inſtant after, ſubſided, and the ſurface again became ſmooth and even.

The nearneſs of my approach to this melted matter, which I obſerved, firſt, during the darkneſs of the night, and afterwards by the light of day, removed every ſhade of doubt or uncertainty reſpecting the remarks I made. It likewiſe furniſhed me with an opportunity to make ſome experiments which I otherwiſe could not have made. I was deſirous to let fall ſome heavy body into the flowing lava; but my ſituation would only permit me to uſe, for this purpoſe, pieces of lava which lay round the cavern, as I could find no ſubſtance of any other

other kind. When I threw theſe pieces into the lava, they occaſioned that dull kind of ſound which would have been produced by ſtriking ſoft earth or thick mud; and at the ſame time formed in the lava an incavation, in which they were buried about one third part of their bulk, and in this ſituation were carried away by the current. The ſame happened when I, at other times, uſed larger pieces, and threw them forcibly into the lava; the only difference was that then they ſunk in deeper.

From this experiment I aſcertained the velocity of the lava, as it is certain that muſt have been the ſame with that of the ſtone carried by it. In about half a minute, the pieces of ſolid lava were carried ten feet and a half. The motion of the current was therefore very ſlow; which was not ſurpriſing, as the declivity was very little. We ſhall ſee preſently, that the pieces of lava with which I made my experiment, were probably of the ſame kind with the lava which was flowing; on which account I,

at firſt, expected that they would have ſunk entirely within it, ſince it is well known that all bodies which paſs from a fluid to a ſolid ſtate become more compact; but a moment's reflection convinced me that the fact could happen no otherwiſe than it did. The pieces of lava which I threw into the current were full of pores and cavities, which in the liquid lava could not have place, or at leaſt could not be ſo numerous: theſe pieces, therefore, muſt be lighter than the liquid lava. Another reaſon, which I conſider as ſtill more deciſive, is derived from the tenacious liquidity of the flowing lava, which muſt prevent the entire immerſion of the ſolid lava, though the latter ſhould be ſpecifically heavier. Thus I have obſerved, that a ſolid globe of glaſs, though thrown with ſome force into a liquid maſs of the ſame matter, will not remain entirely ſubmerged, but float with a part above the ſurface.

I would willingly have made another experiment, which I ſhould have conſidered as of much greater importance; but I had not

not with me the inſtruments neceſſary to undertake it; becauſe I had not the leaſt expectation that I ſhould have been able to approach ſo near to the flowing lava as would have given me an opportunity to have uſed them.

The experiment I mean was to have aſcertained the degree of abſolute heat of the flowing lava, and might have been very conveniently made at this place. As therefore circumſtances did not permit me to make a ſecond viſit to Veſuvius, and as theſe cavities which receive into them the flowing lava are frequently met with in volcanic eruptions, it may not be improper here to detail the nature and mode of the experiments I would have made, had I been furniſhed with the neceſſary means, in hope that ſome ſimilar opportunity may induce ſome one of the few naturaliſts of Naples who are deſirous to enlarge the knowledge we have of their volcano, to carry them into effect.

First,

Firſt, therefore, I would have let fall on the lava within that cavity two kinds of ſubſtances, inflammable and fuſible, contriving ſome means to keep them fixed in the ſame place; punctually noticing the time required for the inflaming of the former and the fuſion of the latter. I would then have expoſed the ſame ſubſtances to our common fires, until the ſame effects had been produced, obſerving the difference of time between the production of the effect by the volcanic fire and the common. I ſhould thus have obtained a term of compariſon of great utility in the enquiry propoſed. But a method more preciſe and certain would be to make uſe of the pyrometer of Mr. Wedgwood *; which ſhould be uſed in the following manner. To aſcertain the abſolute heat of the ſuperficies of the lava, one or more of the cylinders of clay ſhould be let down upon it, encloſed in the box of the ſame earth adapted to them, faſtened to an iron chain that it may not be carried away by the current, and the expe-

* See the Introduction.

riment prevented. This being taken up, after having been ſuffered to remain there ſome hours, the ſhortening of the cylinders would ſhew the quantity of abſolute heat they had ſuffered, and, conſequently, that of the lava on which they had reſted.

But with this experiment alone I ſhould not have been entirely ſatisfied. By the aſſiſtance of this ſame pyrometer, I would have endeavoured to diſcover the internal abſolute heat of the lava, by immerging within it ſome of the cylinders I have before mentioned, enclosed in a thick hollow globe of iron, faſtened to a chain of the ſame metal. The infuſibility of iron in our common furnaces inclines me to believe that it would reſiſt the heat of the liquid lava; but ſhould it not, its melting would ſupply the place of a pyrometer, and ſufficiently prove the violence of the heat.

I am aware that theſe experiments would not aſcertain, with preciſion, the heat of other torrents of lava, which muſt neceſſarily

rily depend on the greater or leſs depth of the ignited matter, its diſtance from the principal ſeat of the conflagration, and the different qualities of the lava. But they muſt have been of conſiderable importance, and I can never ſufficiently regret not having had it in my power to make them.

It may, perhaps, be doubted whether the globe of iron I have mentioned could be made to penetrate through the tenacious ſuperficies of the lava: but there ſeems little reaſon for this doubt, when we conſider that the pieces of porous lava, which are far lighter than this metal, penetrated it to one third of their bulk. And though it ſhould not be able to divide that part of the ſuperficies which, by being in contact with the air, has leſs liquidity; that might be ſeparated by other means, and the globe immediately plunged into the more fluid part of the lava.

I do not deny but that theſe and other ſimilar experiments are difficult, offenſive, and,

in ſome degree, even dangerous; but what experiment can be undertaken perfectly free from inconvenience, and all fear of danger, on mountains which vomit forth fire? I would certainly adviſe the philoſopher who wiſhes always to make his obſervations entirely at his eaſe, and without riſk, never to viſit volcanoes.

But it is time to continue my narrative of the phenomena I obſerved in this eruption of Veſuvius. Though the lava iſſued at its origin from only a narrow aperture, the ſtream of it became conſiderably enlarged as it deſcended the declivity of the mountain, and formed other ſmaller torrents: but at about the ſpace of a mile from the mouth whence it iſſued, its ſuperficies had acquired the ſolidity of ſtone. I endeavoured to paſs over this, notwithſtanding the difficulty of walking on it, as it was entirely compoſed of ſmall disjoined ſcoriæ, on which the foot could not reſt with firmneſs, and ſo hot that I was obliged to change my ſhoes, thoſe I had being worn out, and half-burnt.

Beſides

Beſides two other pits, ſimilar to that I have deſcribed, and ſome burning orifices in which, when I looked into them, I could perceive the liquid lava reſembling melted glaſs in a furnace when it burns with the utmoſt violence, I obſerved, likewiſe, the traces of the courſe which the lava had taken or reſumed. Here the channels through which it had flowed remained, but empty; there ſome reſidue of it was to be ſeen; and others were full of it. One had the form of a cylindric tube, and another that of a parallelopiped. But the direction of all theſe channels through which the lava had flowed, was towards the ſouth. It did not require much attention to perceive, that under the ſolid lava on which I walked the fluid was ſtill running; the low but diſtinct ſound it occaſioned in its paſſage was clearly perceptible to the ear.

A ſufficient illuſtration of what I mean may be given from what frequently happens, in winter, to many ſlow ſtreams, in the northern parts of Italy. In theſe, when

the winter is ſevere, the ſuperficies of the water at firſt adheres to the banks, and afterwards congeals in the middle, forming a cruſt of ice which increaſes in thickneſs from night to night, while the water, which is ſtill fluid, if there is ſufficient depth, continues to run under it; though the thickneſs of the ice increaſes, till after ſome days it is ſufficiently ſtrong to bear men to walk on it, or even greater weights. If any perſon ſhould then go upon it, and apply his ear cloſe to it, he would hear the ſound of the water running under, as I have ſeveral times experienced in the vicinity of Pavia. This ſound appears to me to be preciſely the ſame with that occaſioned by the Veſuvian lava flowing under the ſolid lava, and proceeds doubtleſs from the ſame cauſe; I mean the obſtacles the fluids meet with and ſtrike againſt in their paſſage; as the cauſe of congelation is likewiſe the ſame in both, that is, the privation or rather the diminution of their abſolute heat.

Purſuing my way to the ſouth, along the declivity

declivity of the mountain, I arrived at the part where the lava ran above the ground. Where the ſtream was broadeſt, it was twenty-two feet in breadth, and eighteen where narroweſt. The length of this torrent was two miles, or nearly ſo. This ſtream of lava, when compared with others which have flowed from Veſuvius, and extended to the diſtance of five or ſix miles, with a proportionate breadth, muſt certainly ſuffer in the compariſon; but conſidered in itſelf, and eſpecially by a perſon unaccuſtomed to ſuch ſcenes, it cannot but aſtoniſh and moſt powerfully affect the mind. When I travelled in Switzerland, the impreſſion made upon me by the Glacieres was, I confeſs, great; to ſee, in the midſt of ſummer, immenſe mountains of ice and ſnow, placed on enormous rocks, and to find myſelf ſhake with cold, wrapped up in my peliſſe on their frozen cliffs, while in the plain below Nature appeared languid with the extreme heat. But much more forcibly was I affected at the ſight of this torrent of lava, which reſembled a river of fire. It iſſued

from an aperture excavated in the congealed lava, and took its courſe towards the ſouth. For thirty or forty paces from its ſource, it had a red colour, but leſs vivid than that of the lava which flowed within the cavern I have mentioned above. Through this whole ſpace its ſurface was filled with tumours which momentarily aroſe and diſappeared. I was able to approach it to within the diſtance of ten feet; but the heat I felt was extremely great, and almoſt inſupportable, when the air, put in motion, croſſed the lava, and blew upon me. When I threw into the torrent pieces of the hardened lava, they left a very ſlight hollow trace. The ſound they produced was like that of one ſtone ſtriking againſt another; and they ſwam following the motion of the ſtream. The torrent at firſt deſcended down an inclined plain which made an angle of about 45 degrees with the horizon, flowing at the rate of eighteen feet in a minute; but at about the diſtance of thirty or forty paces from its ſource, its ſuperficies, cleared from the tumours I have before mentioned, ſhew-

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ed only large flakes of the ſubſtance of the lava, of an extremely dull red, which, claſhing together, produced a confuſed ſound, and were borne along by the current under them.

Obſerving theſe phenomena with attention, I perceived the cauſe of this diverſity of appearance. The lava, when it iſſued from the ſubterranean caverns, began, from the impreſſion of the cold air, to loſe its fluidity, ſo that it yielded leſs to the ſtroke of ſolid bodies. The loſs of this principle, however, was not ſuch as to prevent the ſuperficies from flowing. But at length it diminiſhed by the increaſing induration; and then, the ſuperficial part of the lava, by the unequal adheſion of its parts, was ſeparated into flakes, which would have remained motionleſs had they not been borne away by the ſubjacent matter, which ſtill remained fluid, on account of its not being expoſed to the immediate action of the air, in the ſame manner as water carries on its ſurface floating flakes of ice.

Pro-

Proceeding further, I perceived that the ſtream was covered, not only with theſe flakes, but with a great quantity of ſcoriæ; and the whole maſs of theſe floating matters was carried away by the fluid lava, with unequal velocity, which was ſmall where the declivity was ſlight, but conſiderable when it was great. In one place, for ten or twelve feet, the deſcent was ſo ſteep that it differed little from a perpendicular. The lava muſt therefore be expected there to form a cataract. This it, in fact, did, and no ſight could be more curious. When it arrived at the brow of this deſcent, it fell headlong, forming a large liquid ſheet of a pale red, which daſhed with a loud noiſe on the ground below, where the torrent continued its courſe as before.

It appeared to me that it might be expected that, where the channel was narrow, the velocity of the torrent muſt be increaſed, and where it was capacious diminiſhed; but I obſerved that, in proportion as it removed from its ſource, its progreſſive motion

tion became ſlower: and the reaſon for this is extremely obvious; ſince the current of melted matter being continually expoſed to the cold air, muſt continually loſe ſome portion of its heat, and, conſequently, of its fluidity.

At length the lava, after having continued its courſe about two miles, along the declivity of the mountain, ſtopped, and formed a kind of ſmall lake, but ſolid, at leaſt on the ſuperficies. Here the fiery redneſs diſappeared; but about two hundred feet higher it was ſtill viſible, and more apparent ſtill nearer to its ſource. From the whole of this lake, ſtrong ſulphureous fumes aroſe, which were likewiſe to be obſerved at the ſides, where the lava had ceaſed to flow, but ſtill retained a conſiderable degree of heat.

After having written theſe obſervations on the lava ejected by Veſuvius, as it appeared from its ſource to its termination, which I made in company with Dr. Comi Abruz-

Abruzzeſe, a young ſtudent of great promiſe in medical and phyſical ſcience, I had an opportunity to read the accounts of former eruptions, as they have been given by men of great abilities, who had obſerved them on the ſpot, I mean Dr. Serao, Father Della Torre, M. Deluc, and Sir William Hamilton. I perceive that, in the principal facts, the phenomena I have obſerved agree with their obſervations, and that the differences are but few. Thus the torrents of lava which they have deſcribed were accompanied with great fumes, and covered with pieces of lava and ſcoriæ. In like manner the liquid lava received but ſmall impreſſions from the ſtroke of ſolid bodies, and ſometimes none. Serao informs us, that the lava of 1737, when ſtruck on the ſurface with long pointed ſtaves, was found to be ſo hard that it reſounded. According to the obſervation of Father Della Torre, the thick lava of the eruption of 1754, when raiſed with long poles, ſplit into pieces. M. Deluc ſhewed me, ſome years ſince, in his private cabinet

of

of Natural Hiſtory, at Geneva, a piece of Veſuvian lava, of the eruption of 1758, marked with a ſlight impreſſion, which he made in it, on the ſpot, while it retained its ſoftneſs. If this naturaliſt ſhould ever chance to come to Pavia, I could ſhew him, in return, in the public Imperial Muſeum, among the collection of volcanic productions which I have made, a cylinder of lava, 18 inches long, and $5\frac{1}{2}$ thick, which, in one part, has been bent to an angle, while it was half liquid, by the hands of the guide who accompanied me when I viſited the eruption I have above deſcribed. In the eruption of 1766, likewiſe, though the lava flowed with ſurpriſing velocity, we are told, by Sir William Hamilton, that it received but a very ſlight impreſſion from ſome large ſtones that he threw into it. Father Della Torre has alſo remarked another phenomenon which I obſerved, and have deſcribed, relative to the effervescence and tumours of the fluid lava.

But my meeting with the ſubterranean cavity in which the lava flowed, was a fortunate

tunate and ſingular circumſtance, which is not, that I know of, mentioned by any one elſe, becauſe probably it was not ſeen; ſince all the deſcriptions of eruptions which we have, relate ſolely to currents of lava running over the ſurface of the ground, expoſed to the free action of the air; from the effect of which the lava muſt ſoon cool and harden; as appears from the very ſlight impreſſion made by ſtones thrown into it, according to all the accounts I have cited, and my own obſervations. But the narrowneſs of this cavern, and in ſome meaſure its depth, prevented this action of the air; whence I was enabled to obſerve the lava in a ſtate in which it cannot be ſeen above the ground, ſtill retaining a great part of its fluidity, as appeared from its from time to time ſpouting into the air, and from the impreſſions made on it by the pieces of lava thrown into it. It cannot, therefore, be doubted but it had a much greater degree of fluidity when it boiled up in the Veſuvian furnace; as it muſt then have been penetrated with a greater quantity of abſolute heat, by the action of which its

parts

parts muſt have been more disjoined and ſeparated, and therefore have poſſeſſed a greater degree of fluidity and mobility. But I ſhall adduce ſtill ſtronger reaſons to prove the great fluidity of the lava, when it foams and boils up in its craters, when I come to ſpeak of the volcano of Stromboli. I dwell the longer on this ſubject, becauſe I know ſome have denied that the lava is ever fluid, aſſerting, that it has only the conſiſtence of paſte moiſtened with a good deal of water, and deſcends down any declivity in conſequence of its gravity.

To complete the obſervations I have made on this eruption, nothing appears to remain but to ſpeak of the quality of the ejected lava. On this I made different experiments, all of which, ſome extrinſic or accidental circumſtances excepted, furniſhed the ſame reſults. The baſe of the lava is of horn-ſtone rock, of a dark-grey colour, of moderate hardneſs, dry to the touch, where it has been freſh broken ſomewhat earthy, and gives ſome ſparks with the ſteel.

ſteel. This lava put the magnetic needle in motion at the diſtance of three lines and a half, or ſomewhat more than a quarter of an inch.

It is well known to volcanic naturaliſts, that many of the lavas of Veſuvius contain colourleſs garnets. In that of which I treat, they were found very numerous, though very ſmall. When broken, they appeared glaſſy; and ſometimes a kind of ſide or face was viſible, though without its being poſſible to determine the quality of the cryſtallization, not ſo much from their ſmallneſs as from their being too intimately incorporated with their tenacious matrix. With the garnets were united a number of ſhoerls, of the colour and luſtre of aſphaltum, vitreous, cryſtallized in faces, the largeſt of which was nearly five lines. Thoſe which were found in the running lava had received no injury from the fire; but thoſe in the globes ejected from the crater in that eruption, were in a ſtate of beginning fuſion.

The fire of the furnace changed this lava into a kind of enamel, full of bubbles, of the colour of pitch, ſhining, which gave ſparks with ſteel, and adhered ſtrongly to the ſides of the crucible *. The ſhoerls melted, but the garnets did not; they only became whitiſh, but without entirely loſing their vitreous appearance.

After having made my obſervations on the phenomena exhibited by the ſtream of lava then running, I proceeded to examine the veſtiges of others which had flowed ſome time before; one of which, in November 1785, had iſſued at about one third of a mile from its crater, on the ſide of

* To avoid repetitions, I ſhall here mention, that, when I uſe the word *furnace* without any other addition, I always mean the furnace of a glaſs-houſe; and that by the term *enamel*, I underſtand, with the generality of our chemiſts, a ſubſtance produced by heat, reſembling glaſs, but without its tranſparency. It may alſo be proper to add, that, as often as an entire fuſion of the lava took place in the crucibles, it adhered ſtrongly to the ſides.

Monte Somma. As I do not know that any notice has yet been taken of it by others, I ſhall relate the obſervations I made as I paſſed over the remains of it, and likewiſe the information given me concerning it by my guide, and ſome perſons who cultivate the ſtudy of Natural Hiſtory, who had obſerved it on the ſpot at the time of its eruption.

Although at its ſource it was but narrow (as generally happens to theſe ſtreams of lava), it afterwards became conſiderably enlarged, and did not form ſmall, disjoined, and rugged pieces like the others I have deſcribed; but large maſſes, many feet in breadth and depth, and ſeparated by numerous fiſſures. Its ſuperficies preſented an appearance not a little curious. It was rugged and irre[illegible], from an immenſe number of ſmall cylindric bodies, reſembling twiſted cords, and which were only the lava itſelf reduced into ſtriated and contorted fibres, when near the end of its courſe, and ready to congeal. In its qualities it did not appear to me to differ from

from the other Veſuvian lava I had already examined, either in its baſe or the garnets and ſhoerls which it contained.

The greater part of this lava lies in a valley under Maſſa, and on one ſide of Salvatore. Before it arrived there, it muſt have fallen from a high rock, and conſequently formed a cataract, which, when ſeen by night, I was told, exhibited a moſt wonderful ſpectacle to the eyes of beholders. But though its fall through the air muſt have been very conſiderable, and it muſt in conſequence have loſt much of its heat, when it reached the ground it continued ſtill to flow for a conſiderable ſpace. On the ſide of Maſſa, I obſerved that it had approached within ten or twelve feet of ſome oaks which grew on the ſide of a precipice. Some of them appeared entirely withered; others preſerved their verdure only on that ſide of the trunk and branches which was oppoſite to that next the lava. In its paſſage it did ſuch damage to a ſmall church called *Madonna*

della Vetrana, that it has ever ſince remained deſerted. The fiery torrent took it in front, and broke down the wall, which indeed required no great force, as it was built with ſoft ſtones of tufa brought from the neighbouring mountains of Maſſa, and much like that of Naples. Thence it penetrated into the church, and having deſtroyed the door on the oppoſite ſide, and beat down a part of the wall, continued its courſe, through the church, within which it was obſerved to flow with greater velocity than the reſt of the ſurrounding lava, from being confined by the walls on the ſides. With this lava the floor of the edifice ſtill continues covered, and the contiguous ſacriſty partly filled; while large pieces of the broken wall, which the torrent had carried away, lie at more than eighty feet diſtance from the church, in the middle of the hardened lava.—Some linden trees are likewiſe to be ſeen ſurrounded by the ſame, the trunks of which are blackened and burnt. The lava, as I was aſſured, continued to flow fifteen months; and

and when I viſited the place, which was ten months after it had ceaſed to flow, it was ſtill warm, and emitted thin fumes.

On one ſide of Veſuvius, about a mile below Salvatore, is a ſpacious cavern, which widens as we deſcend into it, called the *Foſſa Grande*. I took this way to return to Naples, and gained from it conſiderable and uſeful information. It is well known what doubts have been entertained relative to the ſhoerls and feltſpars which are uſually found, either conjointly or ſeparately, in the lavas; I mean whether they have been formed within them, either while they were fluid, or at the time of their congelation; or whether they exiſted in the original rock before the fire changed it into lava. Bergman has ſtated the arguments on each ſide, but has left the controverſy undecided. It is true, that, when that chemiſt wrote on volcanic productions, the opinion was, with good reaſon, moſt prevalent, which ſuppoſes that the ſhoerls and feltſpars exiſted originally in the primordial rocks. This hypotheſis

has received conſiderable ſupport from the pieces of rock anciently thrown out of Veſuvius, which are to be found on the ſurface of the ground; or by ſearching and digging in the tufaceous matters of the *Foſſa Grande*.

But it is neceſſary to proceed to particulars. One ſpecies of theſe rocks is of a margaceous nature, the carbonate of lime however prevailing. As this did not appear to be at all calcined, but unchanged, and ſimilar to ſtones of the ſame kind which are not volcanic, it afforded a convincing proof that theſe rocks have received no ſenſible injury from the fire; but if we break ſome of theſe, we ſhall find in them numbers of feltſpars, which, in their cryſtallization, and other exterior characters, extremely reſemble many of thoſe we meet with in ſome lavas of Veſuvius, and other neighbouring volcanic places. Still more numerous alſo are the ſhoerls of a ſhining black; ſome of the ſhape of needles, and others of priſms, and varying in their ſize; ſome being ſo ſmall as to be ſcarcely viſible, and others of the

the length of ſeven lines, or above half an inch, and broad in proportion. Theſe pieces of rock do not form veins, ſtrata, or great maſſes, but are diſtributed in different places in ſcattered fragments.

Here likewiſe we find various pieces of granite, not in the leaſt injured by the fire; the quartz of which, beſides mica, is accompanied by feltſpars and ſhoerls, which in no reſpect differ from the volcanic ſhoerls and feltſpars.

I might have conſiderably extended theſe remarks on the ſpecies of rock thrown out by the Veſuvian fires without receiving injury or change; but I think that what I have ſaid will be ſufficient to ſhew, that, in order to account for the preſence of feltſpars and ſhoerls, in lava, and their various cryſtallizations, it is not neceſſary to ſuppoſe them formed within it, either when it was fluid, or at the time of its congelation; ſince we meet with ſimilar vitreous bodies in the ſubſtances from which it derives its origin.

CHAP. II.

THE GROTTO OF POSILIPO—SOLFATARA —THE PISCIARELLI.

The city of Naples founded on volcanic substances—Different opinions relative to the origin of volcanic tufas—Those of Posilipo appear to have been formed by thick eruptions—Lavas on the road to Solfatara described—Specular iron found in one of these —Solfatara is not an isolated mountain, as has been supposed by some—Sulphures of iron (or Pyrites) lavas of Solfatara, and the Pisciarelli—Observations on the decomposition of lava, and the shorls and feltspars which are found within it; as also on the sulphurous-acid fumes which incessantly exhale from this volcano—Conjecture that Solfatara has arisen out of the sea · Method lately employed to extract, more abundantly than formerly, alum and sal ammoniac from this volcano—Critical disquisition

relative

relative to a curious phenomenon in the vicinity of Solfatara, from which M Ferber conjectures that the level of the ſea has, there, ſunk nine feet.

DURING my ſtay at Naples, I determined to viſit the other principal Phlegrean fields as well as Veſuvius, and I had the good fortune to meet with, and have for a companion, the Abbé Breiſlak, formerly Profeſſor of Philoſophy at Rome, and of Mathematics in the Nazarene College; and now Director of Solfatara, near Pozzuolo.

The beautiful city of Naples is entirely founded on volcanic ſubſtances. Among theſe the tufa predominates, which has alſo contributed not a little to the materials of many buildings. To the north and weſt it is accumulated in large heaps, and forms ſpacious hills. A philoſophical ſtranger, on his arrival in this country, when he views theſe immenſe maſſes of a ſubſtance which muſt excite in his mind the idea of fire, cannot but feel aſtoniſhment, and enquire with

with a kind of ſerious thoughtfulneſs, what has been their origin. It is known that on this ſubject naturaliſts are divided. Some conjecture that the volcanic tufa was generated within the ſea when it bathed the foot of the burning mountains; others ſuppoſe that the cinders ejected by the fire, have, in a long courſe of years, been hardened into this ſpecies of ſtone by the filtration of rain water; laſtly, others incline to think that the tufa derives its origin from the ſlimy and fluid ſubſtances thrown out by the volcanos in ſome of their eruptions.

The diverſity of volcanic tufas has, perhaps, been the cauſe of theſe different opinions, each of which may, poſſibly, be true with reſpect to different kinds of tufa. Thoſe, however, which are found in the vicinity of Naples are, probably, the produce of thick eruptions, as we may conclude from the curious diſcovery of Sir William Hamilton, who, in digging up, in the tufa which had covered Herculaneum, the head of an antique ſtatue, obſerved that the perfect impreſſion

preſſion of the head was viſible in the tufa, which cannot be ſuppoſed to have happened but by its having enveloped the ſtatue in a liquid or moiſt ſtate.

To the obſervation of Sir William let me be permitted to add one of my own, which I made in the grotto of Poſilipo. It is well known that this grotto has been excavated within the tufa, and ſerves as a public road from Naples to Pozzuolo. This tufa, which is of a clear grey, has for its baſe an earth in part argillaceous, of a ſlight hardneſs, which contains vitreous flakes, pieces of feltſpars and fragments of yellowiſh pumice-ſtone, which by the changes it has undergone has become extremely friable, and almoſt reducible to powder. This tufa has been in ſome meaſure analyſed by the excavation made in it by art, which furniſhes a proof of the nature of its origin. For if any perſon, in the ſummer time, enters the grotto about the riſing of the ſun, ſince at other times of the day there is not ſufficient light; the ſolar rays, ſhining on the entrance which looks towards Naples, will ſufficiently illuminate

minate the roof and ſides to ſhew layers or flakes, ſimilar to thoſe which may be obſerved on the ſteep ſides of mountains, or in perpendicular ſections of the earth, in low places, where ſediments of various kinds of ſlime have been formed by the inundations of rivers. It ſeems, however, impoſſible to doubt, that this accumulation of tufa, through the midſt of which the Romans opened that long and ſpacious grotto, has been produced by the thick eruptions which have frequently iſſued from volcanoes, and which, heaping up one upon another, have hardened in time into this tufaceous ſtone; ſince both Veſuvius and Etna furniſh ſufficient examples of ſuch eruptions. And as in many other tufas in the vicinity I have obſerved a ſimilar conſtructure; I cannot ſuppoſe their origin to have been different.

Coming out of this ſubterraneous paſſage, and proceeding towards Solfatara, I obſerved, on the right hand ſide of the road, a ridge of lava, nearly parallel with it, which had every appearance of having been thrown out of the

the volcano when burning, both becauſe it was extremely near to it, and had its higheſt part in that direction. Its thickneſs exceeded five-and-thirty feet, and it was ſituated between two layers of tufa, one above and the other below. It formed a high rock, perpendicular to one ſide of the road. A number of labourers were continually employed in ſeparating pieces of this lava, with pickaxes, or other inſtruments proper for ſuch work. It is compact, heavy, ſomewhat vitreous, gives ſparks with ſteel, and appeared to me to have for its baſe the petroſilex. Incorporated with it are found ſhoerls and feltſpars. The former are ſhining, of a dark violet-colour, in ſhape rectangular needles, vitreous, in length, from the ſixth of a line to two lines: it beſides contains a conſiderable quantity of others which have no regular form. But the feltſpars are more conſpicuous than the ſhoerls; both from their larger ſize and greater number. They are, in general, of a flat rhomboidal form, and conſiſt of an aggregate of ſmall white lamellæ, dully tranſparent, brilliant,

liant, marked with longitudinal ſtreaks parallel to each other, cloſely adhering together, but eaſily ſeparated by the hammer, giving ſparks with ſteel more readily than the lava; and, in the full light of day, exhibiting that changing colour which uſually accompanies this ſtone. The largeſt are ten lines long and ſix broad, and the ſmalleſt exceed one line. The ſhoerls are alſo found in the lava, in the ſame manner, and are ſo fixed in it, that they occupy nearly the half of it. It is impoſſible to extricate them entire. They are diſtributed within it without any order, and frequently croſs and interſect each other at right angles.

In ſome ſituations of this lava, which are more than others expoſed to the inclemency of the air and ſeaſons, the feltſpars are viſible on the ſuperficies, by a mixture of emerald and paonazzo, probably occaſioned by the action of the atmoſphere, as from the ſame cauſe ſome volcanic vitrifactions acquire externally their peculiar colour.

This lava has not equal ſolidity throughout, being in ſome places porous, or rather cavernous; and, in ſome of its varieties, it was remarkable, that it abounded with ſpecular iron. This was found in very thin leaves, for the moſt part, cloſely connected together. Theſe are extremely friable; and the finger being paſſed over them, they adhere to it like particles of mica. But their ſmall ſize, which, in the largeſt, is ſcarcely a line, renders it neceſſary to make uſe of a lens to examine them properly; by the aid of which we ſhall find that they are of very different ſhapes, have the luſtre of burniſhed ſteel, and that many of them appear to be an aggregate of ſmall thin ſcales, cloſely united.

This iron acts on the magnetic needle, at the diſtance of two lines. Like many other irons expoſed to the air, it has acquired polarity; attracting the needle, on one ſide, and repelling it on the other.

When we extract theſe thin ſcales of iron from the lava, and examine them with the

the lens, there frequently appear, intermingled with them, various fragments of microſcopic tranſparent priſms, which I, at firſt, thought to be ſhoerls, or feltſpars; but which, afterwards, I rather conceived to be zeolites, as they exhibited the appearance of radii diverging from a centre: but their extreme minuteneſs rendered it impoſſible accurately to aſcertain their ſpecies.

Proceeding along the road to Solfatara, we find, on the left hand, a natural ridge of rock, formed of a very light lava, the baſe of which is horn-ſtone, of the colour of blue baked brick, of a coarſe earthy grain, which attaches ſlightly to the tongue, and gives an argillaceous ſcent, on wetting it, or even merely moiſtening it with the breath *.

* In many lavas, the ſcent of clay is perceived, on moiſtening them with the breath, or by other means: whenever, therefore, I may, hereafter, mention the argillaceous ſcent of lava; I always underſtand it to have been ſubjected to this humectation, though I omit to mention it, to avoid prolixity.

It

It is very probable that this lava has been decompoſed, and that the decompoſition has penetrated to the feltſpars with which it abounds, as they are become very friable, though they in general ſtill retain their natural brilliancy.

Having made theſe curſory obſervations, I proceeded to Solfatara: nor did I ſatisfy myſelf with one viſit only, but repeated it ſeveral days; being extremely deſirous carefully to examine, and gain every information relative to a place ſo celebrated.

From reading the notes of M. Dietrich to Ferber's Travels in Italy; I had been induced to imagine that Solfatara was a mountain iſolated on every ſide*; but the truth is, it is connected with the other neighbouring mountains, with which it forms an uninterrupted chain of conſiderable extent.

* La Solfatare repréſente encore aujourd'hui une montagne aſſez élevée et iſolée de tous côtés.—*Lettres ſur la Minéralogie*, &c. *de l'Italie*, &c.

It would be but of little utility for me to deſcribe, at length, the form, extent, and circuit of this Phlegrean field; the various qualities of the hot vapours which exhale from it; or the hollow noiſe which is heard on ſtriking the ground in various parts of it; not that theſe circumſtances were not carefully examined by me; or that I think them unworthy of my narrative; but becauſe it appears to me unneceſſary to enlarge on them; as they have been already repeatedly deſcribed by a great number of travellers. It will, in my opinion, be more agreeable to the naturaliſt to proceed to a minute examination of the principal productions of this yet unextinguiſhed volcano, as they have hitherto been, for the moſt part, either unobſerved, or paſſed over in ſilence.

In the obſcurity and uncertainty in which we find ourſelves, relative to the cauſes productive of ſubterraneous conflagrations, the ſpontaneous inflammation of ſulphures of iron (or pyrites) has been conſidered as one of the moſt probable. The well-known experiment of Lemery, by which a ſimi-

a ſimilar conflagration is produced by mixing filings of iron with powdered ſulphur properly moiſtened, has given great ſupport to this opinion. But ſulphures of iron, in volcanic countries, are leſs frequent than has been ſuppoſed. This has been clearly proved by the accurate obſervations of mineralogiſts who have written on them. And though Sir William Hamilton expreſsly affirms that both Etna and Veſuvius abound with them *, it is now well known that he miſtook the ſhoerls for ſulphures of iron (or pyrites), from want of mineralogical knowledge. In fact, Signior Dolomieu, in his *Catologo Ragionato de' Prodotti dell' Etna*, mentions only one ſingle piece of lava as containing ſulphure of iron: and the Chevalier Gioeni, in his *Litologia Veſuviana*, has never noticed any ſuch production. In Volcano and Stromboli, two iſlands which are in a ſtate of actual conflagration, I could trace no veſtiges of ſuch ſulphures, as will be remarked in the proper place. As the ſame kind of

* Both theſe mountains abound with pyrites. *Campi Phlegræi.*

ſubſtance, therefore, is found diffuſed in ſeveral parts of Solfatara, I think it well deſerves that we ſhould carefully conſider it, and the bodies with which it is found united.

I. The ſtones which I here undertake to deſcribe are principally found in the interior ſides of Solfatara. The firſt I ſhall mention exhibits, both externally and internally, a number of ſhining particles, which, when examined by the lens, appear to be ſmall aggregates of ſulphure of iron, ſome cryſtallized in cubes, others in globes, and others in irregular figures. When the flame of the blow-pipe is applied to them, they begin to loſe their yellow colour, which, quickly, in conſequence of their deſtruction, entirely diſappears; when an odour ſlightly ſulphureous is emitted.

This ſubſtance is a lava, the baſe of which is horn-ſtone; in part decompoſed, light, friable, granulous, and of a cinereous colour.

II. The ſmall ſulphures of iron in this ſecond

cond lava are leſs numerous, but in their qualities very analogous to that already deſcribed; except that they are leſs decompoſed, and leſs friable.

III. The appearances exhibited by this lava are two. The external part is extremely white; and ſo decompoſed, that the ſlighteſt blow reduces it to powder; we likewiſe find in it ſome of the external characters of ordinary clay. It tenaciouſly adheres to the inſide of the lip; is ſoft to the touch, and becomes ſtill more ſo when ſlightly moiſtened. It abſorbs water greedily, and with a kind of hiſſing noiſe; but is not reducible to a lubricious paſte, as clay is. But the internal part of this lava, beſides being of a grey colour, is three fourths heavier, and in its compactneſs, and its grain, approaches to that ſpecies of calcareous earth, called *calcareus æquabilis*, though, in fact, it only reſembles it in appearance, not being reduced to calx by fire, nor diſſolved by acids. In this lava, the ſulphure of iron is not found in cubes, or globes, but

in thin lamellæ; and is diſperſed throughout its whole ſubſtance, eſpecially in certain parts, where the colour of the ſtone inclines to black, and has a greater conſiſtency. No ſign of this mineral appears in the white decompounded lava, probably becauſe it was deſtroyed gradually, in proportion as the decompoſition took place.

IV. This lava is much heavier than the three preceding; which, no doubt, ariſes from the greater abundance of ſulphure of iron that it contains. The ſhining particles of this mineral are principally to be ſeen in its vacuities (of which, however, it has not many). They are polyhedrous, but the number of their faces is not conſtant. When expoſed to the fire it loſes its braſſy colour, burns with a thin blue flame, and emits a ſtrong ſmell of ſulphur. The lava which contains it, and which is of a livid grey colour, is, in ſome ſituations, ſo ſoft that it may be ſcratched with the nail, but in others much harder, and ſome of it will give ſparks with ſteel. In this lava, the baſe of which appeared

appeared to me to be horn-ſtone, we find cryſtallized feltſpars, but decompoſed, though leſs ſo than the lava in which they are incloſed.

V. Around the extenſive plain of Solfatara, we obſerve, in ſeveral places, a circular ridge of ſteep rocks, which once formed the upper ſides of this enormous crater. The rain water, deſcending this declivity, over the decompoſed lava, carries down with it the more minute parts to the lower grounds, where various concretions are produced, eſpecially thoſe ſtalactites which are commonly called *oolithes*, or *piſolithes*. But of theſe ſtalactites we ſhall ſpeak hereafter. Here we ſhall only notice, that this water, in its deſcent, carries down with it ſmall pieces of decompoſed lava, and that, in ſome places, many of theſe pieces are found united, and bound together by a cruſt of ſulphure of iron. It is black where it is expoſed to the immediate action of the air, but, in the fractures of a ſhining appearance, though the colour inclines more to a lead-

colour than to yellow. Its ſtructure is ſcaly. The ſulphures of iron which have before been mentioned give fire with ſteel; but this does not, from want of ſufficient hardneſs. It abounds with ſulphur; ſince, being expoſed to the flame of the blow-pipe, it viſibly melts, and, the activity of the fire being increaſed, a blue flame ariſes, which continues till the cruſt is conſumed, nothing remaining but a very ſmall quantity of a white pulverous earth, which is no other than a portion of decompoſed lava, that had been united with this ſulphur.

With this ſulphur, the preſence of which is extremely manifeſt from its ſtrong ſmell, is alſo united arſenic; as ſufficiently appears from the white fumes which ariſe from the combuſtion of the ſulphure of iron, and which emit a very ſenſible odour of garlic.

Theſe are the volcanic matters which, at Solfatara, abound more or leſs with ſulphures of iron. But whence is their origin? It is well known they are formed by the combi-

nation

nation of ſulphur with iron. With the former this volcano abounds, whence it obtained the name of Solfatara; and, as the latter is almoſt always found mixed with volcanic productions, which commonly derive from it their varying colours, we have thus the two proximate principles of ſulphure of iron. But is their combination effected by the dry, or, as is more probable, by the humid way? I find it difficult to conceive how it can take place by the firſt method, on account of the ſpeedy diſſipation of the ſulphur ſublimed by fire, which muſt prevent its uniting with the iron to form theſe ſulphures. It appears to me more probable that they have been formed by the action of water, which having penetrated the lava, the ſulphur, diſſolving in the fluid, has combined with the iron. But as ſuch ſolutions of ſulphur in water ſeldom take place, as Bergman has obſerved, we rarely find ſulphures of iron, in volcanized countries, notwithſtanding the exiſtence of theſe two minerals.

But let us continue the deſcription of the productions of this celebrated place, the greater part of which are decompoſed lavas; though this decompoſition, notwithſtanding it has been noticed by ſeveral writers, has not, to my knowledge, been examined, by any one, with requiſite care and attention.

VI. This lava is coloured on the upper part with a covering of oxyde of yellow iron, under which is a white decompoſed ſtratum, to which correſponds another lower one of a cinereous colour, where the lava is much leſs changed. Theſe two ſtrata form a very ſtrong contraſt. The white may be cut with a knife, in ſome places more eaſily and in ſome leſs; adheres to the tongue, does not give ſparks with ſteel, feels ſoft to the wet finger paſſed over it, has conſiderable lightneſs, and being ſtruck with a hammer gives a dull ſound, like earth moderately hardened. On the contrary the cinereous ſtratum ſounds, when ſtruck with a hammer, like a hard ſtone, of which it alſo has

has the weight; is rough to the touch, ſcarcely at all adheres to the tongue, gives fire with ſteel, and cannot be cut with the knife. The white ſtratum, in ſome places, is an inch thick, and in others more, but there are likewiſe places where it is only a few lines in thickneſs. The white ſtratum, in general, changes inſenſibly into the cinereous, but in ſome places the ſeparation is ſudden and abrupt.

The feltſpars in this lava (for of theſe it is full) are priſms; the largeſt of which are ten lines in length, and the ſmalleſt the ſixth of a line. In the cinereous ſtratum, notwithſtanding a beginning decompoſition may be perceived, the feltſpars are unimpaired. On the contrary; in the more decompoſed ſtratum, I mean the white, their decompoſition is very apparent; they have all loſt their tranſparency, though many of them ſtill retain their ſplendour. Others have acquired a reſemblance to a ſulphate of lime that has remained ſome time in the fire; to which they might likewiſe be compared in ſoftneſs, had they a little leſs conſiſtence. Some of them

are infixed in that part of the lava, the colour of which is between the cinereous and white, and here we find them leſs changed than in the ſtratum which is entirely white. Others have one part of them in the white, and the other in the cinereous ſtratum; in which caſe we find the part fixed in the latter ſtratum to have ſuffered nothing, but that in the former conſiderably. In ſhort, from the inſpection of this lava, it is manifeſt, that, in proportion as the nature of it is changed, the feltſpars it contains undergo a change, except when the principle producing the alteration is unable to affect them. Beſides theſe feltſpars, we find, incorporated with the lava, a number of very ſmall, and almoſt inviſible, black ſhoerls; which are not diſtinguiſhable where the lava is white; leſs, perhaps, becauſe they do not exiſt, than becauſe they have loſt their colour, in conſequence of the decompoſition.

This lava, which is of a margaceous baſe, does not liquefy in the furnace, when its decompoſition is conſiderable; but other parts of it, which have been leſs decompoſed, are reduced to a kind of frit.

VII. Sol-

VII. Solfatara, perhaps, does not afford a lava more compact, hard, heavy, or of finer grain than this. Its compoſition is ſiliceous, its colour grey, it gives ſparks ſtrongly with ſteel, and, at the diſtance of two lines, attracts the magnetic needle. Its baſe is of the petroſilex, and it contains within it different feltſpars and ſhoerls; but ſome of the latter have been melted by the fire, as appears from the bubbles or ſpeckles occaſioned by the liquefaction. This lava is covered with a very white cruſt, nearly an inch thick, produced by the decompoſition it has undergone. The effects of the furnace on this lava, are nearly the ſame with thoſe on the lava N° VI.

VIII. This lava is entirely decompoſed. On the ſurface, and for ſome depth, it is white, and almoſt pulverous; but in the internal part the white colour changes into a reddiſh blue, and acquires a degree of hardneſs; though not too great to be cut with a knife. The feltſpars, in which it abounds, have ſuffered different degrees of decom-

decompoſition. Some of them, beſides being calcined, attach ſtrongly to the tongue. Others, when viewed with a common lens, appear full of filaments; but when examined with a deeper magnifier, theſe filaments appear to be no other than extremely thin, ſtriated, and very friable laminæ. This production is infuſible in the furnace.

IX. The feltſpars, in this lava, occupy more than one third of its maſs. They are in ſhape flat priſms, and, except having ſomewhat leſs hardneſs, retain all the qualities which characterize the ſpecies of ſtone to which they belong. There are alſo a number of ſhoerls, which, from their extreme minuteneſs, appear like points, but are eaſily diſtinguiſhable, by their black colour, from the lava, which is whitiſh, and has greater conſiſtence than that of N° VIII. It is likewiſe heavier; to which the quantity of feltſpars but little changed, which it contains, undoubtedly contributes.

X. The ſhoerls which make ſo great a part

part of the other kinds of lava, are found ſo ſtrongly adherent to them, that we uſually can only ſeparate them in fragments. The preſent lava, in this reſpect, offers an exception which may be conſidered as recommendatory of it. It has acquired ſo great a degree of ſoftneſs by its decompoſition, that the numerous ſhoerls it contains may be detached from it entire. They are hexagonal priſms, truncated perpendicular to their axes, the faces of which are ſlightly ſtriated lengthwiſe, and their colour is a yellowiſh black.

In this lava, the baſe of which appeared to me of horn-ſtone, another more remarkable peculiarity preſents itſelf. On breaking it, the fractures diſcover a number of ſmall caverns, jewelled, if I may employ the term, with a multitude of extremely minute ſhoerls, of different colours, ſome green, ſome yellow, others of a dark cheſnut, but all ſimilar, being hexagonal priſms, with rhomboidal faces, and each terminating in a dihedrous pyramid. Their angles

angles are regular, their faces ſhining, and in part tranſparent. They ſometimes form geodes in the body of the lava. To examine them a lens is neceſſary, and a good magnifier clearly to perceive other ſhoerls ſtill more minute. Theſe are infixed in the ſmall cavities I before mentioned, and, though they are extended to a conſiderable length in front of the others before deſcribed, are ſo minute and numerous, that a ſingle cavity will contain a hundred of them. Every one of both theſe kinds of ſhoerls has one extremity fixed in the lava, and the other in the air, and all together appear like a wood in miniature. I was, at firſt, in doubt whether I ſhould conſider them as ſhoerls or volcanic glaſs, as more than one inſtance has been known of ſuch glaſs reduced to a capillary minuteneſs within lava. But the latter appeared to me improbable, becauſe, after all the obſervations that have hitherto been made, we are not yet certain that any volcanic glaſs has been found cryſtallized; for, with reſpect to the pretended cryſtallization of ſome glaſſes in Iceland,

Iceland, we have not facts which demonſtrate it incontrovertibly. On the other hand, the minute corpuſcles I have deſcribed, if not all, at leaſt thoſe which from their larger ſize are more diſcernible by the eye, have a priſmatic figure, and analogy muſt induce us to conclude the ſame of the reſt.

I incline to believe theſe infiniteſimal cryſtallizations produced, after the cooling of the lava, within the cavity in which they are found, from extremely ſubtle ſhoerlaceous ſediments, by the filtration of water. But we ſhall have occaſion to ſpeak of ſimilar adventitious cryſtallizations within the ſubſtance of lava, in another part of this work.

XI. The *Oolites*, mentioned in No. V. lie in certain ſmall channels of Solfatara, through which the water runs when it rains. They are either round, or ſomewhat flattened; rather more than half an inch in diameter, white as ſnow, extremely light, eaſily crumbled, and convertible into an al-

moſt impalpable powder. They adhere ſtrongly to the tongue, and are compoſed of a number of thin ſcales. The formation, therefore, of this volcanic ſtalactites does not differ from that of the other ſpecies.

It would be ſuperfluous to ſpeak here of the ſulphate of lime, adhering to ſome kinds of lava, or of the ſulphate of iron, and the oxyde of red ſulphurate arſenic, as theſe productions of Solfatara have already been ſufficiently examined and deſcribed by others, and I have no particular obſervations concerning them which merit to be mentioned.

XII. It is not uncommon to find at Solfatara pumices of various ſpecies; and it is more probable that they have been thrown out of this volcano than from any of the others. We do not find them in great maſſes, as in other places, but in detached pieces and fragments. I ſhall only remark one particular relative to them, as it appears to me that in every other reſpect they perfectly reſemble theſe already known. We

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now know that pumice is only a glaſs which wants but little of being perfect; and ſeems to require only a degree more of heat to become ſuch. The tranſition from glaſs leſs perfect to perfect, may be perceived in ſome of theſe pumices in a very evident manner. In ſome places their texture is fibrous, and the fibres are vitreous; but without that ſmoothneſs, that luſtre, and that degree of tranſparency, which are inſeparable from volcanic glaſſes. But, following them with the eye, we perceive them conſolidate, here and there, into maſſes of various ſizes, which reſemble a ſhining and ſmooth varniſh, but are in fact perfect glaſs, as will ſufficiently appear, if they be detached from the pumice, and examined ſeparately. Theſe are ſufficiently hard to give ſparks with ſteel, a property obſervable in every volcanic glaſs.

Having now deſcribed the principal productions of the interior part of Solfatara, I ſhall proceed to make a few obſervations on ſome which are found in its exterior; in that part which is next to the Piſciarelli, ſo called from the warm bubbling water, which

iſſues, with ſome noiſe, from the bottom of a little hill contiguous to this volcano, and which has been long celebrated for its medicinal virtues. I collected here ſpecimens of five kinds of lava; but, as in their general qualities they are analogous to thoſe already deſcribed, I ſhall only mention them in a curſory manner.

XIII. The firſt ſpecimen is a ſimple or homogeneous lava, in which, notwithſtanding the moſt careful examination, I could not diſcover either ſhoerls, feltſpars, or any extraneous body. In other reſpects, like thoſe before mentioned, it is decompoſed, adheres to the tongue, is friable, but without crumbling under the finger; its whiteneſs extends through its whole maſs, and wherever it is broken has the taſte of ſulphate of alumine, (or alum).

XIV. The ſecond ſpecimen, through nearly the half of it, exhibits a ſimilar decompoſition, and is of a white colour; but the other half, which is of a lead colour,

has ſuffered little, gives ſparks ſtrongly with ſteel, and moves the magnetic needle at two lines diſtance. This lava has for its baſe the petroſilex. Both that part of it which is ſlightly decompoſed, and the other which is more ſo, contain rhomboidal feltſpars, of which the largeſt are about an inch in length. Their alteration is ſcarcely viſible where the lava is leaſt changed; and where it is more they exfoliate with ſome facility, but retain a conſiderable degree of their natural hardneſs and ſplendour.

XV. The third ſpecimen is a lava of a dark grey colour, ſiliceous where fractured, very compact, and which gives ſparks with ſteel. It is of a petroſiliceous baſe, and contains abundance of feltſpars and ſhoerls. But to ſhew theſe, it is neceſſary to diveſt it of a thick, whitiſh, and half-pulverous cruſt, produced by its decompoſition. In this cruſt the ſhoerls and feltſpars retain ſome conſiſtence, but have loſt, in a great degree, their luſtre.

XVI. The fourth ſpecimen contains within it a nucleus of a deep red colour, of the hardneſs and appearance of the carbonates of lime (calcareous earths), of a fine grain, but which is not diſſolved or affected by acids, nor yields ſparks with ſteel. It attracts the magnetic needle at the diſtance of one line. It contains a number of fiſſures, through which has penetrated, together with water, a quartzous matter, which has conſolidated into a ſemi-tranſparent, and ſomewhat rough, covering. In this lava, which is but little decompoſed, are found, diſperſed, a number of ſmall maſſes of ſulphure of iron.

XVII. Small ſhoerls, and large cryſtallized feltſpars, occupy the ſubſtance of this laſt lava, which is ſomewhat porous, but ſufficiently hard to give ſparks with ſteel. It is covered with a whitiſh-yellow cruſt, which flakes off with a knife, and a reddiſh tincture has penetrated to its internal part, which is of a blackiſh ground.

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In theſe lavas of Piſciarelli, the decompoſition has, likewiſe, been much more conſiderable, than in the feltſpars and ſhoerls which they contain within them.

I do not pretend to be certain that I have enumerated all the ſpecies of lava to be found at Solfatara: it is poſſible there may be others unobſerved by me. I am perſuaded, however, that I have deſcribed the principal; and ſuch as enable me to deduce from their qualities the following concluſions.

I.

Almoſt all the ſpecies of lava hitherto deſcribed, are more or leſs decompoſed, and this decompoſition is uſually accompanied with a proportionable degree of whiteneſs. This obſervation has been made by ſeveral authors; and firſt by Sir William Hamilton, and M. Ferber, who have endeavoured to account for the fact by a very plauſible reaſon, which is, that the ſulphureous-acid vapours, which iſſue from Solfatara, and muſt

have been produced in an infinitely greater quantity, when the conflagration was at its height, penetrating the lava by degrees, have inſenſibly ſoftened it, and given it a white colour. And, in fact, ſimilar changes are obſerved to take place in a piece of black lava, expoſed for a ſufficient time to the fumes of burning ſulphur. But it does not hence follow that this lava will be changed into an argillaceous ſubſtance, as the above-mentioned Swediſh philoſopher would have us believe; ſince, from a chemical analyſis, it appears that an earth of that kind, combined with other principles, pre-exiſted in it, and has only been rendered manifeſt by the diminution of aggregation produced by the before-mentioned vapours.

It is likewiſe not ſtrictly true that the walls, or incloſing ſides, of Solfatara are every where white and decompoſed, as we might infer from the deſcription of M. Ferber. Thoſe which look toward the ſouth, indeed, are ſo, but not thoſe which are ſituated in another direction, and eſpecially thoſe

thoſe which front the north, which are of a blackiſh colour, and little, or not at all, decompoſed. The Abbé Breiſlak, Director of Solfatara, who accompanied me when I made my obſervations, ſuggeſted a very probable reaſon for this diverſity of appearance in the different ſides, obſerving that the ſulphureous acid is leſs powerful to effect the decompoſition of lava, and requires longer time, when the lava has conſiderable humidity; which humidity muſt be much leſs on the ſouthern ſide, where the heat of the ſun is greateſt. In fact, he expoſed a piece of ſolid lava, to a very humid ſulphureous exhalation, at Solfatara, during two months, without producing in it the leaſt decompoſition.

II.

The obſervations I have made, convince me that the alterations here deſcribed always take place in the upper part of the lava; and that, in proportion as we penetrate downwards into it, they become gradually leſs, and, at a certain depth, entirely ceaſe. This,

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at firſt view, does not appear to accord with the effect of ſulphureous vapours, which, riſing from the bottom of Solfatara, and paſſing through the lava, might be expected to cauſe a greater change in the lower parts than the higher, from their having there greater heat, and conſequently being more active. But we muſt conſider that this may indeed be the nature of their action, where the lava is ſpongy, or at leaſt very porous, but not where it is compact, and almoſt impenetrable to ſuch vapours; as is that of Solfatara. And, in fact, we find that the ſulphureous fumes which ariſe there, do not iſſue from the body of the lava, but always from fiſſures or apertures in it, or the ſubjacent tufa. Theſe impediments, therefore, prevent them from acting except on the ſurface, when, iſſuing forth, they are driven over it by the wind, and, penetrating the lava, in a long courſe of time, produce the changes in queſtion. We meet with few decompoſed lavas, within which we do not find fragments of ſulphur adherent, condenſed there by the acids above mentioned, and

and which are of the ſame kind with that produced in ſuch abundance in Solfatara.

But what productive cauſe ſhall we aſſign for thoſe ſulphureous vapours, the ſlow deſtroyers of the lava, which continually iſſue from a number of fiſſures in Solfatara, in the form of hot white fumes? I can conceive no principle to which they can with greater probability be aſcribed than thoſe ſulphures of iron, (pyrites), which abound at the bottom of the volcano, and decompoſing, in conſequence of a mixture with the ſubterraneous waters, ſlowly inflame, and produce thoſe hot ſulphureous vapours, which evidently prove that the ſubterraneous conflagration is not entirely extinguiſhed. The noiſy effervescence, likewiſe which, in more than one place is heard under the plain of Solfatara, ſeems to give a certain indication of the decompoſition of theſe ſulphures.

The ſtreams of vapour, which ariſe from Solfatara, according to Father Della Torre *,

* Storia del Veſuvio.

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in the night, appear like flame. No perſon can be more competent to aſcertain the truth of this fact than the Abbé Breiſlak, who reſides near the place, and who, when I queſtioned him on the ſubject, aſſured me that he had never obſerved any ſuch appearance. It is, however, not impoſſible, but that, at the time he obſerved them, they might have undergone ſome change.

The vapours which ariſe from the ground of the Piſciarelli are very few, and almoſt inſenſible,-though formerly they muſt have been numerous and ſtrong, as may be inferred from the great decompoſition and whiteneſs of the lavas found there. I have already mentioned the noiſe with which the ſprings that bear this name burſt from the earth. They reſemble a boiling caldron. The reaſons aſſigned for this phenomenon, by different authors, are various, but, hitherto, all conjectural. On applying the ear to the place where the ſpring iſſues, we may perceive that the bubbling noiſe does not proceed from any great depth, but from a ſmall diſtance from the ſurface of the

the earth. Were the ground, here, to be dug into, we might, perhaps, be able to diſcover this ſecret, the knowledge of which might prove advantageous to volcanic reſearches. My want of time, and other cauſes, did not permit me to make the experiment myſelf, when I was at Naples; but I entertain a hope that what I have ſaid may induce ſome of the lovers of natural knowledge in that city to engage in this undertaking, which I incline to think will not be found uſeleſs.

III.

We have ſeen that almoſt all the lavas of Solfatara contain within them ſhoerls and feltſpars. But it has been proved that the changes occaſioned in both the latter, by the action of ſulphureous acids, are conſiderably leſs than thoſe which take place in the lavas their matrices; which difference muſt ariſe from the nature of theſe two ſtones, which is leſs liable to extrinſic injuries. We find them, in fact, firmly reſiſt the power of the humid elements. To

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the ſouth of Veſuvius, and at a little diſtance from Salvatore, I have found ſeveral pieces of very ancient lava, porous, and half-conſumed by time, which, however, preſerved unaltered their black cryſtallized ſhoerls.

It has been obſerved that the houſes of Pompeii, long ſince overwhelmed by Veſuvius, and now, in part, dug into, and cleared, are found to have been built of lava. I have aſcertained this fact on the ſpot. They are of a reddiſh colour, very dry to the touch, and ſome of them will crumble under the finger, evident proofs of the change they have undergone; but no ſuch alteration has taken place in the ſhoerls they contain; they ſtill retain the hardneſs and glaſſy ſplendour which is appropriate to that ſtone.

We likewiſe know that the feltſpars are indeſtructible by the air, as appears in the porphyries of which they are a part.

IV.

I have already remarked that the lavas of Solfatara

Solfatara uſually have for their baſis the petroſilex and the horn-ſtone. I ſhall add that I have alſo met with the granite in them, though not in a large maſs, but in ſmall detached pieces, which induced me to doubt whether they properly belong to this volcano; and as they likewiſe appeared to me untouched by the fire, I rather inclined to believe them adventitious. This granite conſiſts of two ſubſtances, quartz and ſhoerl.

But another production muſt not be forgotten, which forms large heaps on one ſide of the internal crater of this volcano. This is an aſh-coloured tufa, of a middling conſiſtence, in ſtrata of various thickneſs, with the ſuperficies of each ſtratum covered with a black cruſt, in which may be diſcovered manifeſt veſtiges of plants. The Abbé Breiſlak, who firſt obſerved this tufa, after having ſhewn it me on the ſpot, gave me ſome of theſe impreſſions of plants to examine, conjecturing them to be ſome ſpecies of the *alga marina*, or, ſea-weed. While I was at Naples, I had not ſufficient time to make

make an accurate examination of them; but this I afterwards made at Pavia, from ſeveral ſpecimens of the ſame tufa. Some parts exhibited only the impreſſions of plants, but in others I found real leaves. They are ſtriated, with ſtriæ running lengthwiſe, and, when touched with the point of a needle, eaſily break, and appear converted into a carbonaceous ſubſtance. At firſt I doubted whether they were plants of the alga; but, on examining them again, carefully, with a lens, and comparing the leaves found in the tufa with thoſe of the natural alga, I was fully convinced they were.

This obſervation appeared, both to me and the Abbé Breiſlak, to be of conſiderable importance; ſince we may conclude from it, that the part of Solfatara which is formed by this tufa, has once made a part of the bottom of the ſea, and been thrown up by the action of ſubmarine fires. Nor is it improbable that the reſt of it has had the ſame origin, and that all the ſubſtances of this volcano have iſſued from the waters of the

ſea.

ſea. Such we know to have been the origin of many other mountains, either now actually burning, or which have ceaſed to burn.

It is well known that, for a long time, alum and ſal-ammoniac have been extracted from this half-extinguiſhed volcano. The method employed for each was as follows. In the proceſs for the alum, certain ſquare places were cleared out in the plain of Solfatara, in which it effloreſced, and the efflorescences were ſwept together, and, from them, by methods well known, the ſalt was collected purified. The ſal-ammoniac was obtained by placing a number of pieces of tile round the apertures from which that ſalt iſſued, in the form of a ſubtle vapour, upon which the vapour was condenſed. A deſcription of theſe two methods is to be found in almoſt all the authors who have written on Solfatara; ſome of whom, with reaſon, cenſure them as imperfect, and, conſequently, not likely to produce the profit which might be obtained.

But we may now hope that both theſe manufactures may become objects of importance, under the direction of the Abbé Breiſlak, and the liberal patronage of Baron Don Giuſeppe Brentano, who has taken this celebrated Phlegrean field at a conſtant rent. The Abbé, proceeding on the principle that the quantity of alum procured from Solfatara muſt be proportionate to the area of the ſpace on which it efflores̈ces, inſtead of the narrow ſquares, formerly appropriated to this purpoſe, and called *gardens*, has greatly extended the ſpaces allotted; and that the preparation of this ſalt may not be prevented, by the rain-water draining into the bottom from the ſteep ſides of the volcano, he has ſurrounded them with ſmall ditches, with deep wells at intervals, which receive the water, and where it is ſoon abſorbed by the ſpongy earth. In the lower part of theſe ſides he has likewiſe opened a number of cavities equally proper to furniſh alum.

The ſame principle appears to have guided

guided the Abbé in his attempts to increaſe the quantity produced of ſal-ammoniac, by making uſe of long and capacious tubes of earth, open at both extremities, and baked in the furnace. Theſe receive, at their lower ends, the vapours abounding with this ſalt, which attaches itſelf to their inner ſides, and forms there a cruſt, that in time increaſes to a conſiderable thickneſs. I have ſeen, with pleaſure, at Naples, the effects of theſe two methods; and it is expected they will be ſtill more productive, when ſome alterations ſuggeſted by perſons well acquainted with this buſineſs have been made.

Formerly ſulphur was extracted from the crater of this volcano; but the ſmall quantity of it, and the low price of the commodity, have cauſed this labour to be abandoned.

Deſcending from Solfatara, a little above the level of the ſea, and near to Pozzuolo, we meet with the ruins of a temple, ſuppoſed to have been dedicated to Serapis, and in

modern times freed from a ſlimy eruption, under which it was buried. This edifice may at once gratify the admirer of the imitative arts, by its architecture, and the curioſity of the naturaliſt. Among the parts which ſtill remain entire, are three beautiful columns of that ſpecies of white Grecian marble, uſually called *cipollino*. They are erect, but, at the height of about nine feet from the ground, each column begins to appear worn; and this wearing extending round the column, forms a horizontal band, or fillet, which is rough and unequal, about two feet in breath, while the remainder of the column is ſmooth and poliſhed. This band is in every part bored by the marine animalcule called *Mytilus lithophagus* by Linnæus, and in ſome of the perforations the ſhells are ſtill to be found, either entire or in fragments.

But beſides this ſpecies, which is well known to Conchiologiſts, I have diſcovered another, which I had before found, in a living ſtate, in ſome ſubaqueous marbles in the

the lake of Venice, an accurate deſcription of which I ſhall reſerve for another work. Several of the ſhells of this mytilus, which is ſmaller than the other, are to be found in the perforations of this part of the column. In fact, on examining with attention, beſides the holes made by the two ſpecies of mytili already mentioned, I found many others, extremely ſmall ones, which all who are acquainted with the different ſpecies of marine animalcula, will know to be the work of other lithophagous worms. I muſt likewiſe add that I have found among them ſome ſerpules, and particularly the *contortuplicata*, and the *triquetra* of Linnæus. Theſe are the marine animalcula which have eaten into the three columns near the middle of the ſhaft, producing that circle of inequalities and roughneſs, except which there is no veſtige of theſe animals.

On the plain of the Temple are found ſeveral other fragments of columns, ſome of the ſame *cipollino* marble with the former, and others of African marble; which frag-

ments have likewiſe bands or fillets of inequalities and roughneſs ſimilar to thoſe before deſcribed, above and below which the marble is perfectly ſmooth, and ſtill retains the poliſh it originally received from the hand of the artiſt.

On the ſame plain we ſee, ſcattered, ſeveral columns of granite, which appeared to me to be oriental; the component parts of which are black mica with large flakes, which is very abundant, a large proportion of felt-ſpar, and quartz. But theſe columns have not been touched by the corroding worms; nor was it to be expected that they ſhould, as it appears, from a variety of inſtances, that they only attack calcareous ſtone.

M. Ferber, in his letters before cited, mentions this appearance in the columns; but he only notices the *mytilus lithophagus*, which he calls the *pholas* or *dactylus*. But the cavities in which theſe pholades have lodged, being nine feet high above the preſent

ſent level of the ſea, he infers that the ſea has ſunk nine feet, ſupporting this inference by the obſervation " that the pholades always reſide in rocks level with the ſurface of the water, and never are found near the bottom."

But this is an aſſumption contrary to fact, as I ſhall eaſily prove. The pholades in theſe columns, which, according to Linnæus and other ſyſtematic naturaliſts, belong to the genus of the mytili, I have very frequently found in the Gulf of Spezia at Genoa, and in its environs, within the port itſelf of that city, in ſeveral places in the ſea of Iſtria, and other parts of the Adriatic, and likewiſe in the Mediterranean. But in all theſe places I have found them in ſubaqueous rocks, never, or ſcarcely ever, level with the ſurface of the water; and, frequently, I have procured them to be fiſhed up from the bottom of the ſea, at the depth of ten or twelve feet, by the means of long and ſtout forceps, which drew up large pieces of the rock, in which they were con-

tained in a living ſtate. I have, alſo, in my poſſeſſion, ſeveral of theſe pholades, or more properly ſpeaking mytili, infixed within the hard ſhells of very large oyſters fiſhed up in my preſence, from the depth of 142 feet. But in theſe columns we find not only the remains of mytili, but of ſerpules and of other very ſmall lithophagous worms which are found in the ſea at every depth. As, therefore, the ſuppoſition of Ferber, that the pholades or mytili always reſide at the ſurface of the water only, is contrary to fact, his deduction that the level of the ſea has ſunk nine feet, ſince the time of the corroding of theſe columns, muſt likewiſe evidently be erroneous. All that we can with certainty affirm is, that the circle, or fillet, which has been the habitation of theſe marine worms, has been covered by the ſea for a long ſeries of years; as may be inferred from the remains of theſe animals found in the cells they have ſunk, which ſhew that they had attained their perfect ſize, to complete which they require nearly half a century, as I could prove by inconteſtable facts,

did

did I not fear it would lead me too far from my ſubject.

It may perhaps be objected that it muſt appear extraordinary, that theſe columns, which are now in an erect poſition, ſhould have been ſo long waſhed by the ſea-water in that circle only, while the part of the ſhaft below it remained untouched. Yet might they not, before they were employed in the fabric of which they made a part, have been buried in the ſea in ſuch a manner that this circle alone, which is now rich with marine ſpoils, might be acceſſible to the water? But though this hypotheſis ſhould not appear ſatisfactory, and I have no other to offer, I ſhall content myſelf with ſtating the facts of which I have knowledge, without feeling any great ſolicitude that I am not able to explain them.

CHAP.

CHAP. III.

THE GROTTO DEL CANE.

Errors of Ferber relative to this celebrated grotto—Experiments of the author and the Abbé Breiſlak, relative to the mortiferous vapour—Deſcription of the grotto—Conjecture that the vapour was anciently more extenſive—Its mean height—Its heat greater than that of the atmoſphere—Conſiſts of carbonic-acid gas, mixed with atmoſpheric air, and azotic gas—This carbonic acid, according to the Abbé Breiſlak, is the produce of the carbure of iron contained in volcanic ſubſtances, and combined with oxygene—The mephitic vapour exhibits no ſigns of magnetiſm or electricity—Phenomena which accompanied the burning of ſeveral ſubſtances placed within the vapour—Remarks of the author on the experiments of the Abbé Breiſlak, and his con-

conjectures on the origin of this carbonic acid.

HAVING viſited Solfatara, and the ſurrounding rocks, continuing my journey to the weſt, I ſoon arrived at the *Grotta del Cane*. There is no perſon converſant with literature who does not know that this name has been given to a ſmall cavern between Naples and Pozzuolo, becauſe if a dog be brought into it, and his noſe held to the ground, he ſoon begins to breathe with difficulty, and loſes all ſenſe, and even life, if he be not ſpeedily removed into the open and purer air. This grotto, though ſo celebrated both in ancient and modern times, in fact ſhares its fame with ſeveral other places which are endowed with the ſame deleterious quality; as it is only one of the almoſt innumerable peſtiferous vapours in different parts of the world, eſpecially in volcanic countries, which are quickly fatal both to brute animals and man, though they do not offer to the eye the ſlighteſt indication of their preſence. They have been mentioned

mentioned by a numerous liſt of writers, whom I might cite, were I diſpoſed to make an unſeaſonable parade of my reading. It is to be remarked that the greater part of theſe vapours are only temporary, whereas that of the Grotta del Cane is perpetual, and ſeems to have produced its deadly effects in the time of Pliny. A man ſtanding erect ſuffers nothing from it; as the mephitic vapour riſes only to a ſmall height from the ground: I, therefore, entered it without danger; but, notwithſtanding the moſt attentive obſervation I could make, I could not perceive the ſmalleſt viſible exhalation.

It therefore appeared to me that M. Ferber muſt have been miſtaken, when he ſays, "the killing damps riſe from the ground, "about a palm above the floor, move along "it as a white ſmoke, and ſpread through "the door in the open air *." But, as it has already been obſerved that the ſmoke of

* Ferber's Travels through Italy, p. 146, of the Engliſh tranſlation.

a torch

a torch extinguiſhed in the vapour ſinks downwards, aſſumes a whitiſh colour, and goes out at the bottom of the door; it appears probable that this occaſioned his miſtake, eſpecially as he mentions the experiment of the extinguiſhed torch in the ſame place.

As little can I agree with him that the miſchievous effects of this vapour are the conſequence of the air being deprived of its elaſticity *; ſince it has been demonſtrated that they are to be attributed to the carbonic-acid gas; as was firſt proved by his learned countryman, M. Adolphus Murray. As we know, likewiſe, that, a candle being extinguiſhed in this gas, the fumes which proceed from it mix more readily with the gas than with the atmoſpheric air; we perceive why the ſmoke of a torch that ceaſes to burn in the Grotta del Cane, ſinks where the peſtiferous vapour is ſtrongeſt, and, paſſing along the ground, goes out at the lower part of the door.

* Ferber's Travels.

The

The perſon who is the keeper, or guide, at the grotto, and who ſhews to ſtrangers the experiment of the dog for a gratuity, when the animal is panting, and half dead, takes him into the open air, and afterwards throws him into the neighbouring lake of Agnano; inſinuating that this ſhort immerſion into the water is neceſſary completely to reſtore him. M. Ferber relates this fact, and ſhews that he believed all that was told him concerning it. The truth however is, that the plunging the dog into the lake is a mere trick, to render the experiment more ſpecious, and obtain money from the credulous, as the atmoſpheric air alone is ſufficient to reſtore the animal to life.

The experiments made by M. Murray, to aſcertain the nature of this mephitic vapour, have diſcovered to us what was before unknown, and we owe to him every grateful acknowledgment. They have not, however, explained every thing we could wiſh to learn relative to this cavern. Whoever is verſed in the knowledge of nature, and acquainted, in any degree, with the difficult

art of making experiments, muſt be convinced what a number of theſe might be made in it, which would greatly tend to throw new light on phyſiology and phyſics. I conceived a ſtrong deſire to attempt ſeveral, and communicated my intention to the Abbé Breiſlak, who accompanied me to the Grotta del Cane. We agreed to divide them between us, that I ſhould apply myſelf to the phyſiological, or thoſe which had for their object living beings, and he beſtow his attention on the phyſical. As I was on the point of ſetting out for Sicily, I reſolved to carry this plan into execution on my return to Naples. But Mount Etna and the Lipari iſles detained me a long time; and when I returned I had ſcarcely time to viſit Veſuvius, being obliged to repair almoſt immediately to Padua, to begin my public lectures in Natural Hiſtory. My friend, the Abbé, however, who reſides conſtantly near Solfatara, in conſequence of his ſuperintendance of the works there, proceeded, after my departure, to fulfil the taſk I had aſſigned him, and communicated to me the reſult of

his

his experiments in a letter, which, with his conſent, I here publiſh, as I am convinced that it will be highly gratifying to my readers.

Naples, November 20, 1790.

RESPECTABLE FRIEND,

WHEN you viſited this city, two years ago, to make obſervations on the Phlegrean Fields, you did me the honour to propoſe to me to aſſiſt you in making a regular ſeries of experiments on the celebrated mephitic vapour of the Grotta del Cane. You may remember that we agreed to divide between us the objects to be examined. You propoſed to inquire in what manner the exhalation acts on the animal œconomy, ſo as firſt to ſuſpend its functions, and at laſt totally deſtroy them, unleſs the means of reſtoration are ſpeedily applied. This problem, though conſidered by many, has never been inveſtigated with that preciſion and accuracy which it deſerves, nor have experiments been ſufficiently multiplied and diverſified to eſtabliſh a general law. From you I expected that it would

would have received new light, accuſtomed as you are to develop the moſt complicated arcana of nature. In the experiments to be made, you reſerved to yourſelf the phyſiological, leaving to me the phyſico-chemical. Your journey into Sicily, and your haſty return to Padua, to exerciſe the duties of your profeſſorſhip, rendered it impoſſible at that time for you to execute your part of the plan. I have not dared to treat a ſubject reſerved for you, but I hope that ſome other, to me fortunate, combination of circumſtances may once more bring you back to Naples, and afford you an opportunity to proſecute theſe inquiries, together with others analogous to them. In the mean time, in ſome excurſions, which I have made to the lake Agnano, I have examined, with the utmoſt attention, this little grotto; and have made ſeveral experiments, by the detail of which I doubt not but you will be gratified. The ſubject, it is true, has been repeatedly examined by many naturaliſts, both natives of Italy and foreigners; but their ſucceſs has

not been ſufficient to preclude every new experiment.

The mephitic vapour, as you well know, occupies the floor of a ſmall grotto near the lake Agnano, a place highly intereſting to naturaliſts from the phenomena its environs preſent, and the hills within which it is included. This grotto is ſituated on the ſouth-eaſt ſide of the lake, at a little diſtance from it. Its length is about twelve feet, and its breadth from four to five. It appears to have been originally a ſmall excavation, made for the purpoſe of obtaining puzzolana. In the ſides of the grotto, among the earthy volcanic matters, are found pieces of lava, of the ſame kind with thoſe we meet with ſcattered near the lake. I examined ſome of them, and found them a compact lava, of a deep grey colour, interſperſed with ſmall hexaedrous priſms of mica. They are of an earthy grain, a micaceous conſiſtence, and have a ſenſible effect on the magnet. Particles of feltſpar are rarely found in them, and

and we meet with no ſpecimens which contain ſhoerls. I am perſuaded that were new excavations made in the vicinity of the grotto, at a level with its floor, or a little lower, the ſame mephitic vapour would be found, and it would certainly be curious to aſcertain the limits of its extent. It would likewiſe be extremely advantageous for phyſical obſervations, were the grotto ſomewhat enlarged, and its floor reduced to a level horizontal plain, by lowering it two or three feet, and ſurrounding it by a low wall, with ſteps at the entrance. In its preſent ſtate, it is extremely inconvenient for experiments, and the inclination of the ground towards the door cauſes a great part of the vapour, from the effect of its ſpecific gravity, to make its way out cloſe to the ground. When I conſider the narrow limits of this place, and the ſmall quantity of the vapour which has rendered it ſo celebrated, I have no doubt but it muſt have undergone conſiderable changes; for it does not appear probable to me that Pliny meant only the preſent confined vapour, when (lib. ii. cap. 93),

enumerating many places from which a deadly air exhaled, he mentions the territory of Pozzuolo. The internal fermentations by which it is cauſed are certainly much diminiſhed in the vicinity of the lake Agnano. The water near its banks is no longer ſeen to bubble up, from the diſengagement of a gas, as we learn that it formerly did, from accounts of no very great antiquity. I have attentively examined the borders of the lake, when its waters were at the higheſt, and after heavy rains, but I never could diſcover a ſingle bubble of air. A number of aquatic inſects, which ſport on the ſurface, may, at firſt view, occaſion ſome deception; but a little obſervation will detect the error. If we do not ſuppoſe thoſe authors who have deſcribed the ebullition of the water near the banks of the lake Agnano to have been deceived, we muſt at leaſt confeſs that this phenomenon has now ceaſed. The quantity of the hepatic vapours, which riſe in the contiguous ſtoves, called the ſtoves of St. Germano, muſt likewiſe be greatly diminiſhed from what it anciently was: for, adjoining to the preſent ſtoves, we ſtill find the

the remains of a ſpacious ancient fabric, with tubes of terra cotta inſerted in the walls, which, by their direction, ſhew for what purpoſe they were intended. It appears certain that this was a building in which, by the means of pipes properly diſpoſed, the vapours of the place were introduced into different rooms, for the uſe of patients, who were accommodated there in a much better manner than they are in the modern ſtoves of St. Germano, which wretched places nothing could induce them to endure but the hope of being reſtored to health. To theſe ruins, however, the vapours no longer extend; ſo that, if this edifice ſtill remained, it could not be employed for the purpoſe for which it was intended. The veins of pyrites which have produced the more ancient conflagrations of the Phlegrean fields, between Naples and Cuma, and which, in ſome places, are entirely conſumed, approach their total extinction. But let us proceed to the experiments made, and frequently repeated, within the grotto.

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I. The firſt had for its object to determine the height of the mephitis, at the centre of the grotto, that is, at the interſection of the line of its greateſt length with that of its greateſt breadth. This height varies according to the different diſpoſitions and temperatures of the atmoſphere, the diverſity of winds, and the accidental variations that take place in the internal fermentations by which the vapour is produced; it may, however, be eſtimated, at a mean, at eight Paris inches.

II. The entrance into the mephitis is accompanied with a ſlight ſenſation of heat, in the feet and lower part of the legs. When, in the year 1786, I viſited the larger mephitic vapours of Latera, in the duchy of Caſtro, I likewiſe obſerved that they produced the ſenſation of heat in the part of the body which was encompaſſed by the mephitic atmoſphere. Yet on taking out of the vapour ſeveral ſubſtances which had remained in it a long time, as ſtones, leaves, carcaſes of animals, &c. I found that theſe were of the ſame temperature with the atmoſpheric

moſpheric air; but as I had broken my thermometer on the road, and was unable to procure another in any of the places through which I paſſed, I could not aſcertain the temperature of the mephitis. I felt in my body a ſlight degree of heat, which I could not perceive in the ſubſtances I took out of the mephitic vapour; and endeavouring to compare one thing with another, I concluded that the temperature of the mephitis was the ſame with that of the atmoſpheric air, which I attempted to explain to myſelf on the principles laid down by Dr. Crawford. But a number of other experiments, made in the Grotta del Cane, have convinced me that this exhalation has a diſtinct degree of heat, different from that of the atmoſphere. In theſe experiments, which I repeated many times, the thermometer, ſuſpended at the aperture of the grotto, three feet above the ſurface of the mephitis, ſtood at between 13 and 14 of Reaumur's ſcale (62 and 64 of Fahrenheit's); and, placing the ball on the ground, ſo that it was immerſed in the mephitic vapour, the mercury aroſe to between

21 and 22 of Reaumur (80 and 82 of Fahrenheit.) Nor ought it to excite ſurpriſe, that the ſubſtances taken out of the mephitis did not exhibit this diverſity of temperature, both becauſe the difference is ſmall, and on account of the quantity of humidity with which they are always loaded, and which produces on their ſurface a continual evaporation. I frequently repeated this experiment, making uſe of different thermometers, becauſe I knew that the celebrated M. Adolphus Murray, when he made his experiments in the Grotta del Cane, had not obſerved the vapour to produce any effect on the mercury in the thermometer.

III. I repeated, for my own ſatisfaction, the uſual experiments, made by many naturaliſts, with the tincture of turnſole, lime-water, the cryſtallizations of alkalis, the abſorption of water, and the acidulous taſte communicated to it, which prove beyond all doubt the exiſtence of fixed air, or carbonic acid, in the exhalation of which we treat. But is it compoſed of fixed air alone? This

I wiſhed

I wiſhed to aſcertain. When expoſed in a eudiometer to nitrous gas, an abſorption took place, to about the $\frac{1}{100}$ of the quantity. In a phial filled with this air, and continued with the mouth immerſed in water for fifteen days, the water ſlowly roſe until it occupied $\frac{4}{100}$: it may, therefore, be concluded that the relative quantities of the different gaſes which compoſe the mephitic air of the Grotta del Cane are as follows: $\frac{1}{100}$ of vital air, or oxygenous gas, $\frac{4}{100}$ of fixed air, or carbonic acid, and $\frac{5}{100}$ of phlogiſticated air, or azotic gas; or perhaps it is a mixture of carbonic acid and atmoſpheric air, with a ſmall quantity of azotic gas, more than is contained in the atmoſpheric air.

The vicinity of the grotto to the ſtoves of Agnano, the warm vapours of which contain a conſiderable quantity of hydrogenous ſulphurated gas, induced me to ſuſpect that ſome portion of the latter might be found mixed with the gas of the mephitis; but I was not able to diſcover in it the ſmalleſt quantity. I made uſe of the ſugar of lead,

lead, or acetite of lead, which, as you well know, is extremely ſenſible to the ſlighteſt impreſſion of hepatic gas, leaving it immerſed in the mephitis for the ſpace of half an hour.

It is certainly a curious problem to inveſtigate the origin of this fixed air. You are acquainted with the different opinions of naturaliſts, ſome of whom conſider it as atmoſpheric air, changed into fixed by the action of the electric matter of the lava; while others ſuppoſe it produced by a ſlow and ſucceſſive decompoſition of the calcareous earth, effected, either by a ſubterraneous fire, or by an acid. But the fact is, that, in the Grotta del Cane, there is not a ſingle vein of lava, and that the atmoſphere of that vicinity exhibits no particular ſigns of electricity. The hypotheſis founded on the decompoſition of the calcareous earth, is, likewiſe, ſubject to great difficulties. Our excellent common friend, the Commendatory de Dolomieu, in his valuable notes to the diſſertations of Bergman on the products of volcanos, is of opinion that the fixed air of volcanic

canic places is produced by the re-action of the ſulphur on the calcareous earth, with which it forms a liver of earthy ſulphur. I am rather inclined to believe that the fixed air of volcanized countries is not developed ready formed from any ſubſtance, but is the produce of the plumbago contained in the iron, with which all volcanic ſubſtances abound, combined with the baſe of vital air afforded by the internal decompoſitions of the pyrites. I am not induced to embrace this ſyſtem by its novelty. The experiments of Meſſieurs Lavoiſier, Berthollet, Mongez, Landriani, and many other excellent chemiſts, compared with local obſervations, have proved, beyond a doubt, the exiſtence of plumbago in iron. It is certain that all volcanic ſubſtances abound in iron, and the hepatic vapours which riſe in the ſtoves of St. Germano, in the vicinity of the Grotta del Cane, prove the internal decompoſition of the pyrites, which ſtill takes place here: a decompoſition, which, by giving birth to the mephitic acid, furniſhes likewiſe the baſe of vital air.

IV.

IV. Among the notices which the celebrated Bergman wiſhed to receive, relative to the Grotta del Cane, he deſired a detail of the phenomena of magnetiſm and electricity. With reſpect to the former, I have obſerved no new appearance. The magnetic needle, placed on the ground, and conſequently immerſed in the mephitis, reſted in the direction of its meridian; and, at the approach of a magnetized bar, exhibited the uſual effects of attraction and repulſion, according as either pole was preſented. With regard to the latter article, it is not poſſible to make electrical experiments, within the mephitis; not becauſe that kind of air is a conductor of the electric fluid, as M. Murray imagined, but becauſe the humidity that conſtantly accompanies it, diſperſes the electric matter, which not being collected in a conductor, cannot be rendered ſenſible. I, ſeveral times, attempted to fire inflammable gas, in the mephitic vapour, with electric ſparks, by means of the conductor of the electrophorus; but, notwithſtanding my utmoſt endeavours to animate the electricity,

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I never could obtain a ſingle ſpark; as the iſolator became a conductor, the moment it entered into the mephitis, on account of the humidity which adhered to its ſurface.

V. One of the principal objects of the reſearches of academies and naturaliſts, at preſent, is the theory of the combuſtion of bodies. My firſt experiment was directed to aſcertain whether thoſe ſpontaneous inflammations which reſult from the mixture of concentrated acids with eſſential oils could be obtained. I placed on the ground, in the grotto, a ſmall veſſel, in ſuch a ſituation that the mephitis roſe ſix inches above the edges of the veſſel. I made uſe of oil of turpentine, and the vitriolic and nitrous acids, and the ſame inflammation followed, accompanied with a lively flame, as would have taken place in the open atmoſpheric air. The denſe ſmoke, which always accompanies theſe inflammations, attracted by the humidity of the mephitis, preſented its undulations to the eye, and formed a very pleaſing object. As I had put a conſiderable quantity of acid

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in the veſſel, I repeatedly poured in a little of the oil, and the flame appeared in the mouth of the veſſel fifteen times ſucceſſively. The oxygenous principle, contained in the acids, and with which the nitrous acid principally abounds, undoubtedly contributed to the production and duration of this flame, though enveloped in an atmoſphere inimical to inflammation.

In the diſtrict of Latera, which I have mentioned above, I obſerved that, in a mephitis of hydrogenous ſulphurated gas, or hepatic gas, a ſlow combuſtion of phoſphorus took place, with the ſame reſplendence as in the atmoſpheric air. As I had not with me a ſufficient quantity of phoſphorus, I could not proceed farther with this experiment, nor vary it as might have been neceſſary. In the mephitis of Agnano, the firſt experiment I made was with common phoſphoric matches, of which I broke five, holding them cloſe to the ground, and, conſequently, immerſed in the mephitis. They all produced a ſhort and tranſient flame,

flame, which became extinguiſhed the moment it was communicated to the wick of a candle. The ſecond experiment I made was the following. I placed on the ground, in the grotto, a long table, in ſuch a manner that one end of it was without the mephitis, while the other, and four fifths of its whole length, were immerſed in it. Along this table, I laid a train of gunpowder, beginning from the end without the mephitis; and, at the other, which was immerſed within it, the depth of ſeven inches, I placed, adjoining to the gunpowder, a cylinder of phoſphorus, eight lines in length. The gunpowder without the mephitis being fired, the combuſtion was ſoon communicated to the other extremity of the train, and to the phoſphorus, which took fire with decrepitation, burnt rapidly, with a bright flame, ſlightly coloured with yellow and green, and left on the wood a black mark, as of charcoal. The combuſtion laſted nearly two minutes, till the whole phoſphoric matter was conſumed.

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I then proceeded to another experiment. I placed ſome gunpowder on the ground in the grotto; and having lighted a cylinder of phoſphorus without the mephitis, I immerged it within it, while burning, carried it the diſtance of ten feet, and threw it on the gunpowder, which immediately took fire. No alteration was perceptible in the flame, or manner of burning, of the lighted phoſphorus, either at the moment of its entrance into the mephitis, or during its continuance in it.

I afterwards lighted another cylinder of phoſphorus, and conveyed it immediately into the mephitis, ſupporting it with a ſmall piece of wood; and this, likewiſe, burnt briſkly, until it was entirely conſumed.

It may, perhaps, be ſuſpected that, in the experiments with gunpowder, the oxygenous gas contained in the nitre co-operated to the combuſtion of the phoſphorus; but it is certain that, independent of the nitre, this curious ſubſtance, though it burnt in

mephitic

mephitic air, preſented the ſame appearances as in the atmoſpheric air. I am aware that, among the experiments of M. Lavoiſier, there is one on the combuſtion of phoſphorus produced by means of a burning mirror, under a glaſs bell, the mouth of which was immerſed in mercury. That excellent naturaliſt obſerved that the phoſphorus began to burn, but that, in a few moments, the air of the receiver being no longer proper to nouriſh the combuſtion, it became extinguiſhed. Is it not probable that the extinction of the phoſphorus did not proceed from the infection of the air, but that the vapours of the phoſphoric matter remaining confined in the receiver, and condenſing around the phoſphorus, ſuffocated its flame? The mephitic gas of the Grotta del Cane is certainly unfit for the reſpiration of animals, and the inflammation of common combuſtible ſubſtances; but phoſphorus, nevertheleſs, burns in it, and emits, as uſual, luminous ſparks.

I muſt not conclude without noticing the production of the phoſphoric acid from the ſlow combuſtion of phoſphorus in the mephitis. Perhaps this may preſent particular modifications, dependent on the carbonic acid, to which it muſt neceſſarily unite itſelf in this ſituation. But I have not yet been able to proſecute this experiment, the temperature of the place not being ſuch as is requiſite to make uſe of the apparatus ſuited to the method of M. Sage. I ſhall therefore defer the inveſtigation of this ſubject until the winter, when I purpoſe to reſume it, if I can procure free acceſs to the grotto, for ſome little time, by ſatisfying the avidity of its rapacious guardian.

I remain,

With ſentiments of the utmoſt

Friendſhip and eſteem,

Your devoted ſervant and friend,

SCIPIO BREISLAK.

The

The obſervations and experiments communicated in the above letter, undoubtedly, enlarge very conſiderably the ſphere of our knowledge, relative to this mephitic place; and I ſincerely congratulate the author on the ſucceſs of his reſearches. But the ſame ſincerity induces me to mention an obſervation which occurred to me while reading his letter, and which, I am convinced, his friendſhip will permit me to make public. The method he uſed to obtain the mortiferous gas on which he made the experiments here related, was, I doubt not, the ſame with that employed to aſcertain the ſalubrity of the atmoſpheric air; that is, by taking a phial filled with water, inverting, and plunging it into the mephitis, then letting the water gradually out, and carefully cloſing the phial. Had any other method been uſed, I doubt not but it would have been mentioned. But by this the mephitis could not be obtained pure, ſuch as it immediately iſſues from the floor of the grotto, but muſt be more or leſs mixed with atmoſpheric air. For the carbonic acid gas being heavier than the atmoſpheric air, it muſt conſequently form a ſtratum in the lower parts

of the grotto, where it will, in general, remain, though there will be ſome mixture of the two fluids; eſpecially when the door is opened, and the internal ambient air put in motion. Hence the mixture of the three gaſes, the carbonic acid, the azotic, and the oxygenous, obtained by the Abbé Breiſlak. I had, however, ſuggeſted to him, that the beſt method to obtain this emanation pure would be to dig a ſmall trench in the ground of the grotto, and to fill it with water; when a number of bubbles would, no doubt, riſe from the bottom to the ſurface, which would probably only conſiſt of the carbonic acid gas ſuſpended in the body of the water. The contents of theſe bubbles might be collected by methods well known, and we ſhould thus procure the genuine mephitis, without any mixture of atmoſpheric air. For greater accuracy in the experiment, mercury might be placed under the water; as it ſeems probable that the tufaceous ſoil would be ſufficiently denſe to retain it.

We have ſeen the opinion of this learned naturaliſt,

naturaliſt, relative to the origin of the carbonic acid in this grotto. It is evident that, in this, as in many other queſtions of a ſimilar kind, we can only amuſe ourſelves with conjecture, and perhaps we may never be able to proceed farther than conjecture, relative to an operation which nature has veiled in profound obſcurity, and withdrawn from the obſervation of our ſenſes. But ſince certainty is not attainable, I muſt ingenuouſly declare, that among the different hypotheſes that have been framed to account for this abſtruſe phenomenon, I prefer that which ſuppoſes that the mephitis of the Grotta del Cane is ſeparated, by the means of fire, from carbonates of lime (or calcareous earths), and that, paſſing through different volcanic ſubſtances, it has penetrated to that place. It is highly probable that the volcanos of the Neapolitan territory, and alſo thoſe of the eccleſiaſtical ſtate, are ſuperincumbent on ſtrata of ſuch carbonates, continued and connected with thoſe of the Apennines. In my way from Lombardy to Naples, when I arrived in the neighbour-

hood of Loretto, the road began to lead between mountains, which continued to Fuligno, a diſtance of nearly ſeventy miles. Theſe mountains, almoſt all with horizontal ſtrata, are compoſed of theſe carbonates. The road from Fuligno to Spoleto and Terni preſents a chain of mountains of the ſame kind, and nearly with the ſame ſtratifications. Theſe mountains extended to within a little diſtance of Civita Caſtellana, where I found ſufficient teſtimonies of extinct volcanos, in the puzzolana and lavas, which I met with at every ſtep. Some of theſe lavas are of a baſe of ſhoerl in the maſs, and others of a horn-ſtone baſe: they all reſemble the Veſuvian with reſpect to the white garnets they contain. The volcanic bodies, and various kinds of tufa and puzzolana, continued to preſent themſelves quite to the gates of Rome. From this city, continuing my journey to Naples, by the way of Veletri, I continually met with volcanized matters; but, at Terracina, the mountains next the ſea again appeared to be formed of calcareous earth, as did thoſe of Scilla.

But, whatever may be the character of the more elevated parts, the bottoms, through which the high road paſſes, conſiſt of tufa, which exhibits the true ſigns of volcaniſation not only in the pieces of lava, and the great number of pumices it contains, but from being in a great degree a mixture of ſmall fragments of lava and ſcoria.

It is to be remarked, and it is worthy of attentive conſideration, that when we leave the road, and aſcend the ſteep eminences on its ſides, we frequently find beneath the tufa, calcareous ſtone, eſpecially in places where the former has been corroded by rain water. The remainder of the Apennines from Seſſa to Naples are formed of the ſame calcareous ſtone; though, in lower ſituations, the volcanic tufa is ſcarcely ever interrupted.

In Chap. VI. I ſhall ſpeak of a volcano which I obſerved near Caſerta, a ſmall city about ſixteen miles from Naples. I ſhall then ſhew that the volcanic matters are

there every where ſurrounded by calcareous ſtone.

The Foſſa Grande, which deſcends laterally from Mount Veſuvius, and which I have mentioned in Chap. I. is bordered on the ſides by two high rocks. That which is on the left, the ſide towards Naples, owes its origin to an aggregate of lava; while that on the right is compoſed of pumice-ſtone and tufa; which not being firmly connected frequently fall by their own weight, eſpecially when looſened by rains, and, in their fall, bring down with them various ſubſtances, of which ſome are calcareous ſpars, mixed with pieces of the common calcareous earth, which, as I have already mentioned, I met with in my journey to Naples. Theſe ſubſtances ſeldom exhibit any traces of injury by the fire: their angles, likewiſe, are not blunt or ragged, but ſharp. It is, however, indubitable that they are pieces rent from great maſſes of calcareous ſtone, before the vehemence of the

fire

fire had time to change them. Theſe obſervations I made on my return from Veſuvius to Naples.

The author of the *Campi Phlegræi*, ſpeaking incidentally of the Foſſa Grande, gives the figure of a piece of calcareous breccia found there; and obſerves that ſimilar pieces are frequently found in the excavations made by the rains in the ſides of Veſuvius and Monte Somma. The *Lithologia Gioeniana*, which treats on the productions of this volcano, mentions ſimilar calcareous ſtones to have been thrown up from its mouths in former times.

The iſland of Capri, near Naples, it is to be obſerved, is likewiſe compoſed of calcareous earth.

From all theſe obſervations, it appears to admit of no doubt that the Neapolitan territory, which we ſee volcanized, reſts on calcareous ſtrata. This was likewiſe the opinion of Ferber and Sir William Hamilton.

If,

If, then, we ſuppoſe the ſubterraneous fire to act gradually on the calcareous ſtone, compelling it to diveſt itſelf by degrees of its acid, while it becomes covered with earthy aggregations eaſily permeable to this acid, now become gaſeous, the gas will iſſue above it, and form a current mingling with the atmoſpheric air. This, probably, will explain the nature of the emanation in the Grotta del Cane. The Abbé Brieſlak has ſhewn that the heat of this emanation is greater than that of the atmoſphere; which affords us reaſon to ſuppoſe that a remainder of volcanic fire exiſts under the grotto. The great humidity of the vapour is, likewiſe, extremely favourable to this hypotheſis, ſince we know that calcareous ſtone, by the action of fire, is not only deprived of its acid, but of the water which it contained. It may be objected that, on this ſuppoſition, the mephitis muſt diminiſh; but it ſhould be conſidered that its extent is very confined, while the quantity of the ſubjacent calcareous matter is immenſe; and it is likewiſe

well

well known what a prodigious quantity of this acid is combined with ſuch ſtones.

This hypotheſis will likewiſe explain the temporary mephites, which ariſe only in conſequence of particular eruptions, as frequently happens in the environs of Veſuvius. The deleterious exhalations will continue till the ſubterraneous fires have decompoſed the calcareous ſtones; but they ceaſe when the conflagrations are extinguiſhed.

CHAP.

CHAP. IV.

LAKES OF AGNANO AND AVERNO—MONTE NUOVO—PROMONTORY AND CAVERN OF MISENO—ROCK OF BURNT STONES—PROCIDA.

The lake of Agnano once a ſpacious volcanic crater—Tenches and frogs found in this lake—The abſurd report that monſtrous animals are produced there, detected by Valliſneri—The lake of Averno preſents the mouth of another ancient volcano—It is falſe that birds cannot approach this lake—No deleterious exhalation emitted by it—Volcanic ſubſtances of Monte Nuovo—Lavas found there of the nature of pumice and ſmalt—Soda grows in a little cavern of its crater—Peculiarity of amphibious animals obſerved here—The cavern of Miſeno abounds in ſulphate of alumine (alum) and pumice—Well of water

full

full of gaſeous bubbles. Volcanic crater ſtill diſcernible on the promontory of Miſeno —Pumices found there, containing felt-ſpars. Lava, pumices, and enamels of the ſame nature, found on the Rock of Burnt Stones, and at Procida—Great friability of this enamel, not common to volcanic enamels, and its probable cauſe.

THOUGH the Phlegrean fields are numerous, I in this work propoſe to deſcribe or at leaſt to give a ſketch of them all; ſince, though they are all volcanic, the objects they preſent are few, and little different from each other.

I believe no one doubts that the cavity filled with water, and uſually denominated the lake of Agnano, has been the mouth of a volcano. It certainly has internally the reſemblance of one, ſince it is ſhaped like an inverted funnel, the uſual figure of volcanic craters. It muſt have been a very large one, ſince it is nearly two miles in circuit. Numerous flocks of ducks ſwim on its ſurface, and

and its waters contain great quantities of tenches and frogs, which were once celebrated for a pretended monſtrous formation: until the cauſe of this abſurd error was detected by Valliſneri. It may not, perhaps, be uninſtructive, ſhould I, by way of an amuſing digreſſion, relate the ſtory of this pleaſant miſtake to the reader.

It is well known that frogs, before they arrive at the perfect form of their ſpecies, have that of a kind of worms, uſually called tadpoles; the bodies of which are of an orbicular ſhape, and have tails. We know likewiſe that theſe tadpoles become frogs by degrees, the hinder legs being firſt produced, and afterwards the fore-legs, while they retain the tail for a conſiderable time. This gives them a ſtrange appearance, as the tail appears like the lower half of a fiſh, while the round body and legs reſemble the frog. Hence perſons unacquainted with the productions of nature have ſuppoſed them to be monſtrous animals, half fiſh and half frogs. A credulous Neapolitan brought one of theſe monſters,

monſters which he ſaid was a native of the lake Agnano, to Valliſneri, at Milan, that he might view it and admire. It did not, however, require the knowledge of ſo great a naturaliſt immediately to perceive the abſurd error. The tadpole, which to him was an object of laughter, not of admiration, was of an extraordinary ſize, whence he concluded that the frogs of the lake Agnano were extremely large. They are not, however, larger than the common ſize, nor did I find the tadpoles bigger, though, as it was the end of July, they had arrived at their full growth, and many, having caſt their tails, had become perfect frogs. That which was ſhewn to Valliſneri was, poſſibly, brought from ſome other country, perhaps America; where the frogs grow to an extremely large ſize.

The ſides and bottom of this lake are of tufa, interſperſed, in ſome places, with fragments of lava and pumice-ſtone; though we do not find, at leaſt ſo far as the eye can reach, any veins or ſtrata of lava: whence I infer the eruption to have been entirely,

entirely, or in a great degree, thick and ſlimy.

The ſame ideas which naturally occur to the obſerver at ſight of the lake Agnano, will be ſuggeſted, likewiſe, by that of Averno, as there can be no doubt but this likewiſe was the crater of an ancient volcano. The Greeks called it *Avernus*; becauſe no birds were found near it, probably on account of ſome peſtilential vapour which then exhaled, and deprived them of life. The author of the *Campi Phlegræi* aſſerts that it is very rarely that any water-fowl are to be ſeen on this lake, and that when they come they remain there but a very ſhort time. The truth, however, is, that, whenever I was there, I ſaw great numbers of teal ſwimming on the ſurface; and the peaſants aſſured me that the lake abounded with water-fowl in the winter. Nor do I know any cauſe which can, at preſent, drive them from a place where they may find plenty of food; as neither the environs, nor the lake itſelf, afford any indication of noxious exhalations.

Theſe

Theſe two places lie to the weſt of Naples, near Pozzuolo, in the vicinity of which is Monte Nuovo, ſo called becauſe it was produced by ſubterranean fires in 1538. It is not very high, and, ſeen from the port of Pozzuolo, appears to be an obtuſe cone; but, on reaching the top, we diſcover that this cone is only the exterior part of a crater, the upper edges of which form a circle of about one hundred and fifty feet in diameter.

Like other volcanic craters, the internal ſides of this grow narrow towards the bottom, and both that which I call the bottom, and the external part of Monte Nuovo, conſiſt of a friable tufa, in many places, covered with plants. The ſea bathes the ſides of this volcano, which, if they are dug into a little, as well within the water as without, are found very warm. The ſame warmth is likewiſe perceived at the bottom of the crater. From ſuch excavations, likewiſe, ariſe thin warm vapours. In fact, in the internal parts of Monte Nuovo we find

all the laſt remains of volcanic conflagration.

In the external ſides of the mountain many pieces of lava are found, which deſerve notice from their ſingular quality. They are a ſubſtance of a middle character between lava and pumice-ſtone, on which account I ſhall call them pumice-lavas. They have the lightneſs and friability of a compact pumice-ſtone. When broken by the teeth, by which a good judgment may be formed of ſome ſtones, they appear real pumice-ſtone. They are dry and rough to the touch, as is uſual with ſuch kinds of volcanic productions. Their ſtructure is not fibrous, contrary to what we obſerve in common pumice-ſtone, but granulous, and very ſimilar to that of various kinds of lava, as is likewiſe the internal appearance. This production is of importance, as preſenting a middle ſubſtance between lava and pumice-ſtone. The baſe of theſe ſtones is a horn-ſtone, mixed with a few feltſpar ſcales:

they ſcarcely adhere to the tongue, and emit a ſlight argillaceous odour. In the furnace they produce a compact enamel, of a dark grey colour, tranſparent at the angles, and which gives a few ſparks with ſteel.

Towards the internal bottom of the crater we find, projecting from the tufa, the ſame kind of lava, penetrated with feltſpars, but more compact and heavy, and interſperſed with beautiful and ſhining veins of black enamel of various thickneſs. I am in doubt whether this ſpecies of vitrification was the conſequence of a greater degree of heat to which the lava had been there expoſed, or whether, from the difference of its quality, in thoſe places, it had undergone a more perfect fuſion, and become enamel, while in others it had remained in the ſtate of lava.

On the ſide of this bottom we find, within the tufa, a ſmall cavity, I know not whether formed by nature or art, that abounds with

ſaline efflorescences, which I at firſt imagined to be muriate of ammoniac (ſal ammoniac), or ſulphate of alumine (alum); but their urinous acrid taſte, the green colour which they gave to ſyrup of violets, and other qualities that are proper to ſoda, and which I omit for the ſake of brevity, leave no doubt that they are formed from that ſalt. Beſides theſe efflorescences, the ſmall hollows, corners, and bottom, of this cavity are more or leſs covered with the duſt of this ſoda.

I cannot take leave of this volcano without mentioning an obſervation, which has ſome analogy to what has been before noticed of lake Agnano, as it relates to the ſame ſpecies of animals. On the tufaceous ſides of the crater, both internal and external, as often as I approached them, I ſaw a great number of frogs leaping about. They were nearly half an inch long, and a quarter in breadth. They had the complete form of the frog, were of a dark-yellow colour, and their fore-feet were divided into four toes, and

and their hinder into five, though they have not the ſhape of the hand, which conſtitutes an eſſential difference between theſe frogs and the others of theſe countries. But how are theſe amphibious animals produced? Among all the different ſpecies of European frogs (and, under this genus, I, with Linnæus, likewiſe include toads) I know none which do not begin their exiſtence in water, and continue to live in it ſome time, until they throw off the maſk of the tadpole, and aſſume the ſhape of frogs. But Monte Nuovo is not only entirely without moiſture, but, as I learned from the peaſants who reſide in the neighbourhood, even when heavy rains fall, the bottom of the crater (which is the only place where rain-water can be collected and retained) imbibes all the water immediately; as, in fact, it muſt, ſince it conſiſts of a light ſpongy tufa full of cracks and fiſſures.

The only water near, is that of the lake Agnano, about half a mile diſtant; from which theſe animals might be ſuppoſed to have derived their origin, were it not that the

frogs of that lake are of a totally different ſpecies. I muſt therefore confeſs, that the preſence of theſe creatures here was to me an enigma, which, perhaps, I might have been able to have ſolved, not without ſome advantage to natural knowledge, had I been able to have made a longer ſtay in this volcanic country.

Before we reach the promontory of Miſeno we arrive at the harbour, which is a very ſecure baſon, as it is ſurrounded on every ſide by eminences. This was the port for the Roman fleet in the Mediterranean. The eminences are of tufa; and, on one ſide, a little above the level of the ſea, we find a ſpacious cavity, the work of art, called the Cavern of Miſeno, in which the muriate of alumine continually efflorecſces. This ſalt is either unknown to or neglected by the inhabitants; though it might be extracted with great advantage, eſpecially were the cavern enlarged (which it might eaſily be, as the tufa is extremely ſoft), ſince the ſaline efflorecſcences would certainly increaſe

in

in proportion to the enlargement of the ſuperficies.

At the bottom of the cavern there is a well of water bubbling up, with ſometimes more, ſometimes fewer, gaſeous bubbles, which riſe from the bottom. The water is nearly of the ſame temperature with the atmoſphere, and the gas, from the ſcent, appears to be ſulphurated hydrogenous; but I had not convenient opportunity exactly to aſcertain its quality. The ſides and roof of the cavern are ſcattered over with common pumices, containing various feltſpars, ſome calcined, and conſequently deprived of their native luſtre, without, however, having loſt their natural cryſtallization, which is rhomboidal.

Beyond the port of Miſeno is the promontory of the ſame name, which forms a tufaceous mountain of no deſpicable height; from the top of which ſome admirable proſpects preſent themſelves. This, likewiſe, certainly owes its origin to a volcano, as its

crater is ſtill very diſcernible, though in a great meaſure deſtroyed, on the ſouth ſide, by the waves of the ſea.

Having proceeded to ſome diſtance from this promontory, I met with ſeveral lavas immerſed in the tufa, both of the compact and porous ſpecies, but common to other volcanos, and all detached. Mixed with theſe were various pieces of pumice, in like manner detached, in which feltſpars were, I will not ſay, ſcattered, but thickly ſown. In a ſquare inch of this pumice I counted fourteen on the exterior ſurface, and forty-ſeven within. They are cryſtallized with various faces, are ſomewhat leſs hard than quartz, and have that changeable brilliancy which is inſeparable from feltſpars. The fire does not appear to have been able to injure them, though it has changed their baſe into pumice, which is in fact a real vitrification.

In front of Procida, and at a little diſtance from it, a ſmall low rock projects into the ſea, formerly only known to fiſhermen, and called

called the *Rock of Burnt Stones*, becauſe it is, in fact, a mixture of pumices, enamels, and lavas. The firſt naturaliſt who noticed it was the Abbé Brieſſak, who conducted me to it with a particular kind of pleaſure, as a place appertaining to himſelf. A ſtay of two hours, which I made on it, was well rewarded by the objects it preſented. Its elevation above the ſurface of the water is only a few feet, and conſequently, in tempeſtuous weather, it muſt be covered by the waves. On making the circuit of it in a boat, and examining it, we find that only the projecting points riſe above the water, and that the body of the rock is below the ſurface. Hence it appears probable, that it was once much larger, but has been in a great degree deſtroyed by the violence of the waves.

The ſtones of which this rock is compoſed are principally of two qualities. The firſt, a lava of a horn-ſtone baſe, light, of a dark grey colour, an earthy grain, unequal, and which gives ſcarcely any ſparks with ſteel.

ſteel. The ſecond is a lava, with a baſe of ſhoerl in the maſs, which has undergone various changes and modifications, according to the different heats to which it has been expoſed. In many fragments, therefore, we only find it a ſimple lava, while, in others, it has become pumice, and in others enamel. Some pieces attract our obſervation, by being partly converted into pumice, and partly into enamel. In one part they appear of a whitiſh colour, fibrous, light, and extremely friable; but, as their levity and friability diminiſh, they become more compact, and the fibres leſs diſcernible; the colour grows darker, and a glaſſy luſtre begins to appear. A little farther, their fibrous quality is entirely loſt; their compactneſs, weight, hardneſs, and luſtre increaſe, and the unequivocal characters of a perfect enamel are ſeen. This latter is black, gives ſparks with ſteel, and in its appearance reſembles the aſphaltum. Its black colour is interrupted by feltſpars, which are likewiſe common to the firſt lava with the horn-ſtone baſe. They are extremely brilli-

ant,

ant, ſomewhat fibrous, cryſtallized in hexaedrous priſms, and ſeveral of them five lines in length.

It frequently happens, that the volcanic productions which exiſt in one place are found likewiſe in another: that is, that, in diſſerent ſituations, the earthy matters and the activity of the fire have been the ſame; a concurrence which may eaſily take place in various parts of the globe; and which is exemplified in the ſimilarity of a corner of the iſland of Procida to the Rock of Burnt Stones. The iſland is ſituated to the weſt of the rock, and is about ſix leagues in circuit. The ſhore, being an accumulated maſs of tufa, abounds with ſhrubs and plants. This tufa, on the ſide next Iſchia, having been much corroded by the ſea, affords a diſtinct view of its ſtructure, which is in ſtrata; whence we may infer that it has been the production of ſucceſſive fluid depoſitions. To the north-weſt of the iſland is a rock, on which we find pumices, pumiceous lavas, and enamels, both pumiceous and

and pure, accompanied with feltſpars, and the other concomitants with which they are found on the Rock of Burnt Stones; on which account it would be only loſs of time to recapitulate their deſcription. I met with only one new ſtone, which was a common granite, in which were diſtinctly diſcoverable its three conſtituent parts: the feltſpar in ſhining needles; a lightly livid, and ſlightly calcined, quartz; and a black mica, which did not ſhine. It could not therefore be doubted, that it had been expoſed to the action of the fire. But as I found this granite looſe on the ſhore, detached from the volcanic products I have before mentioned, I ſhall notice it no farther.

From the lavas of the horn-ſtone baſe, found on this rock, we obtain, in the furnace, a very compact and hard enamel, which affords ſparks with ſteel; and from the lavas the baſe of which is ſhoerl in the maſs, as alſo from the pumice and the enamel, which originate from the ſame ſtone, is produced a ſcorified enamel, ſo ebullient, that a great part of

of it boiled over the edges of the crucible, though it was only half full. This violent fuſion, however, produced no ſenſible change in the feltſpars.

I ſhall conclude this chapter with an obſervation relative to the enamels of the Rock of Burnt Stones, and Procida. They are extremely friable; a ſlight ſtroke with a hammer will break them into pieces; whereas the enamels of moſt other volcanos, as we ſhall ſee in their reſpective places, poſſeſs conſiderable hardneſs, and a much greater than that of common glaſs. I imagine this defect may be cauſed by the ſea-water, which is mixed with them, and raiſed from the ſea by the action of fire and aëriform fluids. Thus we know, that thoſe liquid vitreous ſubſtances which are congealed and conſolidated in water, are much more friable than when hardened in the air. I am confirmed in this opinion by obſerving, that a number of cracks and fiſſures are to be found in theſe enamels, an appearance we likewiſe obſerve in glaſs which has been

dropped into water while in a ſtate of fuſion. It is to be remarked that theſe enamels, while they were fluid, have received within them ſeveral extraneous bodies; as pieces of tufa and lava, ſands and earths of various kinds, which are found within them more or leſs calcined.

It is probable, from the ſmall diſtance between Procida and the Rock of Burnt Stones, that they once were joined, and have been ſeparated, in the courſe of a long ſeries of years, by the action of the ſea.

CHAP.

CHAP. V.

ISCHIA.

The caſtle of Iſchia founded on a rock of lava and tufa—Singular ſpecies of ſwallows, which make their neſts at its top, and on the higher eminences of the iſland—Lava of the Arſo deſcribed—Its pumices originate from the horn-ſtone—The opinion of ſome volcanic naturaliſts, that the lava of the Arſo, which flowed in 1302, *ſtill ſmokes, ill founded—Lavas and pumices ſcattered between the city of Iſchia and the Arſo—Conical mountain, called the Rotaro, compoſed of lavas and pumices—Is the only one in the iſland which contains enamels—The high mountain of St. Niccola, probably, at firſt, roſe out of the ſea—Volcanic ſubſtances of that mountain—Some of thoſe ſubſtances yield ſulphate of alumine (alum)—Excurſion round the ſhore of Iſchia—*

Volcanic

Volcanic productions found there—Ferruginous ſand abundant on that iſland—Is found to be all cryſtallized—Enquiries concerning its origin—No priſmatic configuration in the lavas which fall into the ſea—The aſſertion of ſome modern writers, that the lavas of the ſhores of Iſchia are a nidus for the pholades, greatly to be doubted—The Stoves of Iſchia, the only probable indication of a remaining internal conflagration—Conſiderable diminution of this iſland—Difference between the volcanic materials of Iſchia and thoſe of the other Phlegrean Fields—Singular property of the feliſpars of the Iſchian lavas, which melt in a glaſs furnace, whereas thoſe of other lavas are almoſt always infuſible by its heat.

THE volcanic ſubſtances of which this iſland, eighteen miles in circuit, is internally compoſed, prove, beyond the poſſibility of doubt, that it owes its origin to fire. The obſcure epochs of the eruptions of theſe ſubſtances have been fixed, by conjecture, by M. Niccola

Niccola Andria, the learned Profeſſor Royal in the Univerſity of Naples, in his intereſting work, entitled, *Delle Acque Termali**, in which, before he treats of the warm ſprings of Iſchia, he gives a detail of the natural hiſtory of the country, in which he diſplays equal learning and ingenuity. To this work I refer the curious reader, who will find it extremely inſtructive.

I ſhall, however, according to the plan I originally propoſed to myſelf, proceed to deſcribe the principal productions of this iſland which owe their origin to fire, adding ſuch remarks as the ſubject may ſeem to render neceſſary. I ſhall begin therefore at the caſtle of the city of Iſchia, which is built on a rock ſurrounded by the ſea, and a little more than a quarter of a mile in circuit. Lava and tufa are the two component ſubſtances of this rock. The former is different in its appearance, according to the different places in which it is found; but its qualities appeared to me to be ſubſtantially the ſame. Its baſe

* On the waters of hot baths.

is horn-ſtone: it is compact, of a moderate hardneſs, an earthy appearance; of a black colour externally, but greyiſh within. Its dead lurid hue is diverſified by a few ſparkling rhomboidal feltſpars.

The furnace produced from it a very compact enamel, of a mixed colour, between that of honey and dark blue, without any alteration in the feltſpars.

The tufa has no quality by which it is diſtinguiſhed from the common.

On examining the direction of the tufa and the lava, it was found to continue the ſame in the neighbouring mountain, which is ſeparated from the rock by a narrow channel of the ſea: whence it is obvious to infer, that ſeveral currents have deſcended from the mountain and plunged into the water, thus forming the rock, which has been divided from the iſland by the action of the waves.

A number of black and white ſwal-

lows* make their neſts in different parts of this caſtle, and in the clefts of the rock. The ſteep and lofty rocks of the iſland, likewiſe, afford a ſecure retreat to theſe birds of paſſage.

Leaving the caſtle and the city of Iſchia, and proceeding about a mile to the weſt, we meet with a torrent of lava, called the *Arſo*, (or Burnt Ground) which is the moſt recent of any in the iſland, ſince it flowed in 1302, and is deſcribed by Villani, in his Hiſtory of Florence. It extended about half a mile in breadth, and about a mile and a half in length, and would have flowed farther, had it not met the ſea, in which it was buried. The courſe of the torrent appears interrupted by eminences and deſcents, and, at ſome diſtance, preſents to the eye the reſemblance of an immenſe number of large heaps of mulberries confuſedly thrown together. It has no viſible crater, if by that term we underſtand, as is uſual, a mouth more or leſs enlarged towards the edges, and contracted

* Hirundo melba. Lin.

at the bottom; for the lava iſſued from a narrow cleft, at the foot of Mount Tripeta. Though it is little leſs than five centuries ſince this lava flowed, a gloomy ſterility reigns upon it; it does not produce a ſingle blade of graſs, and only affords, in ſome places, a few arid and uſeleſs plants of the lichen, or liverwort. On the ſurface, and for a little depth, it is light and ſpungy, and eaſily crumbles; but, deeper, it becomes denſe and harder. The ſame is obſervable in many lavas, and is the natural effect of the laws of gravity: the lighter parts of a liquid maſs riſing to the ſurface, and the heavier ſinking to the bottom.

This lava is of the horn-ſtone baſe, and has an earthy ground. Its colour is different in different places, and varies from that of iron to a reddiſh black. The feltſpars incorporated in it are extremely numerous, and, when attentively examined, in ſome ſpecimens, may induce us to conclude that the fire which produced this torrent muſt have been extremely violent; ſince we find the feltſpars more or leſs melted; though, generally,

generally, thoſe included in lavas appear not to have undergone the leaſt alteration. When we take the lava of the Arſo from ſome depth, in the middle of the current, we find this fuſion of the feltſpars extremely apparent. Some appear transformed into little globes, or cylinders; others have been only melted on one ſide, on which they have loſt their cryſtallized form, though they have preſerved it entire in other parts. In ſome cavities of the lava, where the fuſion of the feltſpars has been more conſiderable, we meet with ſingular appearances, which well deſerve notice. Sometimes the melted feltſpar hangs, as it were, in the air, attached only by ſome radiating threads of the lava itſelf, in the centre of which it hangs; while another, melting in the ſide of a cavity, takes the ſhape of a tranſparent concave veil. Even thoſe that have not undergone fuſion exhibit deciſive ſigns of a ſtrong calcination. They are extremely friable, and their ſhining changeable colour is in many places turned to a dead white. In conſequence of this calcination, the cyſtals are often

often no longer found entire, but ſcattered in ſmall fragments in the body of the lava. Thoſe in the lava on the ſides of the current are leſs injured, and their cryſtallization is in quadrangular faces.

As the volcanic fire had reduced many of the feltſpars in this lava to a ſtate of fuſion, I determined to try what effect I could produce on them in the furnace; but though I kept them there two days, I could only obtain a ſimple calcination.

M. Dolomieu, ſpeaking of the iſland of Iſchia, tells us, that the eruption of the Arſo, though we know it continued two years, never produced any pumice, but only black ſcoriæ *. It is true, I could only find ſcoriaceous lava on the ſurface, and ſolid lava in the internal parts, through the whole length of the courſe of the torrent, except at the aperture whence it had flowed; where, amidſt a great quantity of fragments of lava, I

* Catalogue Raiſonnée des Produits de l'Etna.

found

found ſeveral pieces of pumice, ſo completely characteriſed, that there was no danger of confounding them with the light and poroſe ſcoriæ, which have been frequently, by perſons of inſufficient diſcernment, taken for pumices. Theſe, beſides being dry and rough to the touch, were fibrous, with long fibres, vitreous, extremely light, ſhining, and brittle; whereas the texture of the ſcoriæ and ſcoriaceous lava of the Arſo is granulous, or ſo confuſed that no ſhadow of a fibre appears; nor have they much friability. In other reſpects, theſe pumices of the Arſo agree in ſubſtance with the ſcoriæ and lava of the ſame place: the feldſpars in them are alike, and equally affected by the fire. This obſervation proves, therefore, that the horn-ſtone, by a violent fire, may be changed into a true pumice, though this tranſmutation rarely happens.

The above-mentioned French naturaliſt likewiſe aſſerts, that the lava of the Arſo ſtill ſmokes in many places; and that the white fumes which ariſe from it are very

viſible in the morning when much dew has fallen.

This aſſertion, though it muſt appear ſomewhat extraordinary, would certainly merit belief had M. Dolomieu himſelf been an eye-witneſs to the fact; which had he been, he certainly would have told us. As, however, he only expreſſes himſelf in general terms, it is probable he relied on the information of others. The Abbé Breiſlak and myſelf made our obſervations on the Arſo, at the moſt proper time for diſcovering theſe fumes. We repaired thither at ſun-riſe, and paſſed there the greateſt part of a morning in which there was no want of dew; but our eyes ſought this wonderful appearance in vain. Nor could we learn that it had been ſeen by any other perſons; thoſe, at leaſt, of the inhabitants of the vicinity whom we interrogated on the ſubject, and they were not few, nor people likely to deceive us, all declared that they had never ſeen either ſmoke, vapour or miſt, ariſe from the Arſo. However, notwithſtanding

ſtanding this, I will not take upon me abſolutely to deny the fact. I will only ſay, that I find it difficult to overcome my doubts: nor am I convinced by the inſtances adduced, by M. Dolomieu, of ſome lavas of Etna which have not yet ceaſed to ſmoke, though they were ejected in 1762; ſince the time elapſed in the latter caſe is only twenty-ſix years, but in the other four hundred and eighty-ſix.

On my return to the city of Iſchia, I met with three lavas riſing from the earth like huge rocks. The baſe of all the three was the horn ſtone, but they were diſtinguiſhed from each other by certain exterior characters.

One of them was of a cinereous colour, of a coarſe grain, but compact, dry, and rough to the touch. In its external appearance it was not unlike to ſome ſand-ſtones.

The ſecond was of a ground entirely earthy: its compactneſs, weight, and hardneſs were, however, greater than thoſe of the firſt lava.

The

The third, in its recent fractures, was half vitreous; gave ſparks with ſteel, but languidly; and was more fixed, heavy, and hard, than the two others.

All theſe three lavas had an argillaceous ſcent, and contained numerous feltſpars ſo brilliant and perfect that they appeared to have entirely eluded the violence of the fire.

A number of detached pumices accompanied theſe lavas, which they reſembled in their general qualities: they contained feltſpars and ſhoerls, but both reduced to a beginning ſtate of fuſion.

But no part of the iſland ſo abounds with pumices as the Rotaro, a mountain ſituated between Caſamicciola and the city of Iſchia. This mountain is of a conical ſhape, and compoſed of tufa, pumices, and enamels. It appears to have been produced by a thick and ſlimy eruption, and is divided into ſeveral ſtrata, particularly diſtinguiſhable in the road called *Via del Rotaro*. Between theſe

ſtrata there is an immenſe quantity of pumices, differing in their ſize, colours, and denſity; but ſimilar in their texture, which in all is fibrous. They contain various felt-ſpars, which manifeſt a beginning fuſion. They do not form continued currents, as we obſerve in many of the pumices of Lipari, but are found in detached pieces; yet ſo diſpoſed, that, in many places, they form beds or ſtrata. It appears extremely probable, that the volcano, after an eruption of tufa, threw up a ſhower of pumices, which falling on the tufa produced a bed or ſtratum, upon which another eructation formed another tufaceous ſtratum, that was again covered with another ſhower of pumices; and thus, by alternate ejections of tufaceous and pumiceous matters, a great part of the conical mountain was formed. The extent of the pumices, in the direction of the *Via del Reparo*, is more than a mile; and they principally abound in the more elevated places, where thoſe moſt proper for the purpoſes for which theſe ſtones are uſed in Italy, may be collected in great abundance.

Inter-

Intermixed with the pumices and tufa, we find many pieces of enamel, the thickneſs of which is from an inch to a foot and a half, and even two feet. Theſe were probably thrown out at the time when the above-mentioned mountain was formed. They are of a black colour, and yield to the ſtrokes of a hammer much more than the enamels of the Rock of Burnt Stones and Procida. Like them, they abound in felt-ſpars, and preſent the uſual rhomboidal figure. The Rotaro is the only place in Iſchia which affords enamels.

It ſeems as if it might be conſidered as an invariable rule, that, among the mountains of different elevation which have given birth to volcanic iſlands, that which riſes above the reſt, and is commonly placed in the centre, was firſt produced by the fire; and that thoſe which ſurround it, and, by their junction and extent, form the b[illegible] of the iſland, are the work of ſucceeding eruptions, which have iſſued either from the crater of the primitive mountain, or from the

the lateral and lower craters, whence have been ejected that aggregate of ſubaltern and ſucceſſively lower mountains, by which the moſt elevated, which occupies the centre, is ſurrounded. In this manner, we perceive ſeveral of the Eolian iſles to have been formed. Such alſo has been the origin of Iſchia; where the mountain of St. Niccola, which in earlier times was called Epopeo, and which is in the centre of the iſland, and higher than the reſt, was no doubt the firſt that towered above the waves. The conſtituent ſubſtances of this mountain are of various kinds. I have conſidered, with ſome attention, thoſe on the ſide of Lacco, which are ſtones that, in the ſame manner as thoſe of Solfatara, have undergone a decompoſition, probably to be attributed to ſulphureous acids, if from the reſemblance of effects we may argue a ſimilarity of cauſe. The rocks near the ſea, on the coaſt of Faſano, are leſs decompoſed; nor is it difficult to diſcover their nature, which is granitous; the mica, feltſpar, and quartz, being clearly diſcernible, with ſome greeniſh particles of

ſteatites.

ſteatites. The quartz and feltſpars, though ſomewhat calcined, are tolerably hard; and the mica, which is black, has not loſt its native ſplendour. This rock, which does not appear to have ſuffered fuſion, is whitiſh, and changed in ſuch a manner that it will not reſiſt a blow of the hammer.

Proceeding towards the ſummit of the Epopeo, we meet with decompoſed lavas, partly of the horn-ſtone baſe, and partly of that of the petro ſilex, in which, however, the argilla occupies no ſmall part. The lavas of this latter quality, in part not affected by the ſulphureous acids, are of a black hue, of conſiderable compactneſs, give ſparks freely with ſteel, and in their fractures, and ſometimes externally, preſent a ſiliceous appearance. Their odour is ſenſibly argillaceous. Theſe petroſiliceous lavas are not ſimple, but contain within them ſome ſmall flakes of feltſpar and mica.

In the furnace they melt into a ſubſtance of the colour and luſtre of pitch, in which, however,

however, the white feltſpars appear, or rather are conſpicuous.

Theſe lavas are found to be variouſly decompoſed by the acids, in the ſame manner as is obſervable in thoſe of Solfatara. In ſome places, they are covered with a thin whitiſh cruſt, light, ſoft to the touch, which attaches to the tongue, and is extremely friable. In others, this cruſt is ſome inches deep, and in others, it extends through the whole thickneſs of the lava. Sometimes we find it ſo ſoftened that it has become pulverous; and there is a great quantity of white duſt on the brow of the mountain. We may therefore conclude that the ſulphureous acids have there been very abundant, and of long duration; though now there is no perceivable ſign of any ſuch exhalations.

We know that formerly in Iſchia the ſulphate of alumine (alum) was extracted for commercial purpoſes; and according to M. Andria, who has been before cited, the

manufacture of this ſalt was principally carried on at Catrico, a place ſituated above Lacco, on the higher eminences of the Epopeo. He informs us, however, that he was not able, after the moſt careful and minute reſearch, to diſcover any remaining veſtige of ſulphate of alumine. I will candidly ſtate what I myſelf obſerved.

I collected a number of ſpecimens of the different lavas of Catrico and the environs. They are generally compact, very white, and homogeneous to the eye; but they differ from each other by the following exterior characters: Some are moderately heavy and hard: in their recent fractures, and frequently without, they are ſmooth; and in the centre of ſome we find a ſmall nucleus of blackiſh lava, but little decompoſed. Others are very light, may be ſcratched by the nail, are rough and ſomewhat pulverous in their fractures, and ſcarcely ever contain within them any reſidue not decompoſed. In ſhort, the former lavas have undergone leſs change by the ſulphureous acids than the latter.

latter. When I firſt examined, on the ſpot, the fragments of theſe two lavas, I could not perceive by the taſte any ſymptom of the ſulphate of alumine; but when I had conveyed my ſpecimens to Pavia, together with other volcanic ſubſtances, and placed them in my cabinet, on large tables, after ſome months I obſerved the following appearances:

In the lavas of Catrico and its vicinity, which had been leſs affected by the acids, I could diſcover no trace of alum; but in the other lavas of the ſame ſituation, which had been more changed by the ſaid acids, I perceived the ſweetiſh and aſtringent taſte of that ſalt; and could diſcover a whitiſh thin coat of the ſame, which entirely incruſted them.

At the end of ſix months the thickneſs of this coat was a quarter of a line; after which, I did not perceive it to increaſe in thickneſs. I made new fractures in theſe lavas, and continually diſcovered new coats

of the ſulphate of alumine; and at the time I now write, which is twenty-ſeven months ſince I brought the ſpecimens of lava from Iſchia, they ſtill retain a thin ſaline cruſt. I have alſo ſatisfactorily aſcertained the true nature of this ſulphate of alumine, by the ordinary chemical proofs.

As to the ſecond ſpecies of lava, it never, at any time, exhibited any ſign of the preſence of this ſulphate; nor have I been able to obtain it by calcination, and a method ſimilar to that which is employed in the territory of Civita Vecchia for extracting alum from ſuch argillaceous ſtones.

Theſe obſervations, however, ſufficiently prove, that this valuable ſalt might ſtill be obtained at Iſchia; nor ſhould it excite ſurpriſe that, when on the ſpot, I could not diſcover it by the taſte; ſince the humidity of the night, the dew, and ſtill more the rains, had diſſipated it as faſt as it efflorеſced. As the ſpecies of decompoſed lava in which I diſcovered it is found in very large quantities

quantities on the Epopeo, this branch of commerce, which has been ſo long neglected in Iſchia, might doubtleſs be revived with very great advantage.

Beſides the places I have mentioned, I examined this iſland in many others, without diſcovering any novelty worthy of remark; but I could not entirely ſatisfy myſelf with ſuch excurſions. When I firſt formed the deſign of attentively examining Iſchia and the other Eolian iſles, I reſolved not only to make my reſearches in their interior parts, but to coaſt their ſhores in a boat, landing at ſuch places as appeared the moſt ſuitable to my enquiries. In this manner I met with many volcanic bodies, which I ſhould have ſought in vain within the iſland; either becauſe they do not exiſt there, or becauſe they are rendered inacceſſible by the rocks and precipices with which they are ſurrounded, or which they themſelves form. The coaſts of the volcanic iſles are alſo clothed with lavas, which run out into the ſea, and which, in

ſome places, by tracing them upwards, diſcover the crater, or mouth from which they have iſſued. Laſtly, by coaſting the ſhores of the iſlands, we may be enabled to determine, whether the priſmatic lavas owe their origin to the ſea; many writers of repute having aſſerted that the regularity of their form ariſes from the ſudden congelation that takes place on their precipitating into the ſea-water, which cauſes them to take the ſhape of regular priſmatic columns; a configuration which, they affirm, is only found in places adjoining to the ſea.

For theſe reaſons I determined, after having examined the higher parts of the iſland, to proceed to conſider the lower; and took my departure from Lacco, by water, coaſting the iſland on the left. The firſt mountain which preſented itſelf was the Vico, partly formed of tufa, and partly of two currents of lava, which deſcend into the ſea. The colour of the firſt, which is of a horn-ſtone baſe, is between the grey and iron colour: it is of an unequal grain, earthy, moderately hard;

hard; and abounds in feltſpars, ſome in thin plates, others in priſms, and both conſpicuous for their brilliancy.

The other lava, which is of the ſame baſe, and contains ſimilar feltſpars, is leſs compact, more earthy, and, conſequently, leſs hard: its colour is partly cinereous, and partly grey. Theſe two lavas, in their deſcent, have raiſed themſelves into little mounts, and are of a conſiderable thickneſs.

Farther on is Monte Zaro, formed, towards the ſea, by a river of lava extending a mile in length, and nearly two in breadth. It appears to have been generated by ſeveral ſucceſſive eruptions, which have conſolidated one after the other. The baſe of this lava is horn-ſtone, and it contains mica and feltſpars. It is various in its colour, being in ſome parts of the current of a more or leſs reddiſh blue, in others cinereous, and in others white. The mica, which is black, and eſpecially conſpicuous in the white

pieces, though it has not undergone fuſion, has loſt its luſtre, and acquired a much greater degree of friability than it naturally has. The ſame has not happened to the felt-ſpars, which are as well preſerved as if they had never been expoſed to the fire. They give ſparks plentifully with ſteel, have a beauteous changeable luſtre, are of a vitreous, ſemitranſparent whiteneſs, and, being broken, are detached with difficulty. This ſpecies of lava ſo abounds with them, that they occupy the full half of its volume. The greater part are priſms.

Another lava makes a part of the ſame current of Monte Zaro. This, though it is likewiſe of a horn-ſtone baſe, differs from the former by being one third leſs heavy, and of an earthy appearance; whereas that of the other is ſomewhat vitreous. Its colour, in the more internal parts, is reddiſh; but, in the external, an ochreous yellow. On the ſurface eſpecially it is manifeſtly decompoſed; for it is become ſo ſoft that it may be ſcraped with a knife. But the cauſe

which

which has produced this ſuperficial decompoſition in the lava has not injured the feltſpars, which are extremely perfect, and, in this lava, may be eaſily extracted, to examine their figure, which is hexagonal with rhomboidal faces. Some of them are half an inch in length, though others are not more than a line.

The bottom of Monte Zaro, which is waſhed by the ſea, is covered with a vitreous ſand; which, viewed with a lens, appears to conſiſt of a number of particles of feltſpars, which by liquefaction have had their angles blunted, and been reduced to a roundiſh figure. They belong to the feltſpars of the laſt-mentioned lava.

From the termination of Monte Zaro to the beginning of Monte Imperatore is a long and ample tract, almoſt entirely tufaceous, ſcattered over with *rapillo*, as the Neapolitans call it; or, as a naturaliſt would ſay, with fragments of pumice.

The ſide of Monte Imperatore which over-hangs the ſea, derives its origin from a very ſingular ſpecies of lava. I have already ſpoken of the abundance of feltſpars in the lava of Monte Zaro; but in this they are found ſo prodigiouſly numerous, that at firſt view they appear to conſtitute the entire ſubſtance. It is neceſſary to break it, and conſider the pieces attentively, to perceive that it has a baſe, which is of a yellowiſh earthy horn-ſtone, eaſily friable, to very ſmall quantities of which the feltſpars are feebly attached. Their cryſtallization is in rhomboidal faces of various ſizes, from a line to three quarters of an inch. To this little earthy baſe are likewiſe attached various ſmall ſcales of black hexaedrous mica.

The ſame Monte Imperatore preſents us, on the ſide of the ſea, with large quantities of another lava; which, excepting a very few particles of yellow mica, and ſome ſtill fewer microſcopic feltſpars, may be conſidered as ſimple. This likewiſe has for its baſe the horn-ſtone. The lava appears to have

have iſſued from the mouth of the volcano at different times, as we find currents which have flowed over currents, intermixed in a ſtrange and confuſed manner.

Leaving the Monte Imperatore, we next arrive at the Calle di Panza; a place on the ſhore, from which riſes a very high and large rock of lava, interrupted by ſome protuberances, that attract the eye at a diſtance, and invite obſervation, which they certainly merit, as they conſiſt of beautiful groups of numerous rough rhomboidal felt-ſpars, ſome two inches in length. They are of a yellowiſh white, tranſparent in a ſlight degree, of a vitreous appearance, a changing aſpect, a foliating texture, and manifeſt their hardneſs by the quantity of ſparks they give with ſteel. Many hundreds of them, grouped together, form roundiſh maſſes of half a foot, a foot, and two feet in thickneſs, which at their lower extremity are ſet in the lava. Though, as has been ſaid, they are very hard; yet, by the means of certain fiſſures they contain, they may eaſily be

be divided into ſmall pieces, either of the parallelopipedon or rhomboidal form. Whence it appears that they have been injured by ſome external agent, but which ſeems to have had no relation to ſulphureous acid vapours, as we do not perceive the ſmalleſt indication of theſe, either in the feltſpars, or in the lava which contains them. This agent, however, whatever it may have been, has produced a conſiderable effect on the lava, which is corroded in every part; and it is in conſequence of its being ſo deeply corroded, that the groups of feltſpars have been left uncovered, ſo that they may eaſily, with an iron point, be extracted entire.

This fact appeared to me the more deſerving of remark, as in all my former volcanic reſearches I had never met with any ſimilar: nor indeed have I ſince; the feltſpars of other lavas being never grouped, or forming a kind of tumours, but ſcattered, and diſtributed within them in equal quantities. But in what manner are we to conſider theſe tumours? Are they extraneous bodies

bodies that have been by accident included within the lava while it was in a fluid ſtate? This is poſſible; but it appears to me much more natural to ſuppoſe that they appertained to the ſtony ſubſtance which has been changed into lava by the violence of the fire. I would, therefore, thus explain this phenomenon. Since, as we have already obſerved, the feltſpars (and the ſame may be affirmed of the ſhoerls) are not the produce or conſequence of the fire, as they are found to exiſt in many of the primordial rocks; it appears moſt probable that they were formed within thoſe rocks when they were in a ſtate of fluidity, or at leaſt ſufficiently approaching it. I mean to ſay, that then the integrant particles of the feltſpars, by their powerful affinity, united in cryſtallized maſſes. Where they were at a certain diſtance from each other, they united, forming complete cryſtals; but where they were thickly cluſtered, their tumultuary union produced groups of cryſtals, the greater part of which were of irregular forms. The ſame may be obſerved in ſalts, ſtones, and eſpe-

cially in quartzoſe and ſparry cryſtals. Thus, with reſpect to the feltſpars in this lava: they are contained in every part of it; and, where there is any ſpace interpoſed between them, their cryſtallization is perfect; but very imperfect in the groups I have deſcribed, and probably from the cauſe ſuggeſted above.

This lava, like the preceding, has for its baſe the horn-ſtone; and the external appearance of its current reſembles that of a ſtream which, precipitating from a height, has been ſuddenly congealed and hardened by cold. It abounds, therefore, in inequalities, elevations, and deſcents; and, on obſerving its principal track, which paſſes by the Calle di Panza, we are led to expect that the aperture whence it flowed lies higher, in the direction of that place, where it is in fact found.

A ſtrong wind riſing from the ſouth, though it did not prevent me from coaſting the iſland, hindered me from landing,

as there was danger of being daſhed on ſome rock by the violence of the waves. I could therefore only obſerve at a diſtance a variety of lavas, and a great quantity of tufa, which, being continually beaten and diminiſhed by the waves, form precipices, and cliffs, hanging over the ſea.

I however continued my reſearches by removing to the northern ſide of the iſland, where I was ſheltered from the wind; but I did not find that the volcanic productions to be met with here preſented any novelty. They were almoſt all of the horn-ſtone baſe, and filled, as uſual, with cryſtallized felt-ſpars.

I did not fail to collect and examine the ſand of the other parts of the iſland where I landed, as well as that of the ſhore near Monte Zaro. I found it, as I expected, to be of the ſame nature with the volcanic productions at the foot of which it was found. The greater portion of the ſand conſiſted, however, of ſmall fragments of feltſpars;

feltſpars; that being the ſtone which moſt abounds in theſe lavas, and which beſt reſiſts the viciſſitudes of the ſeaſons, and every extrinſic injury.

I muſt not omit to mention the ferrugineous ſand which we meet with in many parts of the iſland, and which is eſpecially abundant on the ſea ſhore. It not only moves the magnetic needle, but is ſtrongly attracted by the loadſtone. This ſand is well known in Naples, and other places; but one of its qualities, which I diſcovered with the aſſiſtance of a lens, has not, to my knowledge, been hitherto obſerved. At the firſt view I imagined, with the generality of naturaliſts, that it muſt conſiſt of very minute particles of iron, of entirely irregular ſhape, like thoſe of lapidarious ſands. Such, in fact, they appeared to the naked eye; but, by the aid of a good lens, I diſcovered, with pleaſing ſurpriſe, that every grain was the fragment of a cryſtal, or a complete cryſtal, of native iron. Of the latter there were not more than three or four among

every

every hundred grains. Theſe ſmall martial cryſtals are formed of two quadrangular pyramids united at the baſe, and every ſide of the pyramid is a rectangular or iſoſceles triangle. But, in general, we meet with only the fragment of a cryſtal, and perceive that the part wanting has been deſtroyed by the action of the waves of the ſea on the ferrugineous ſand; many of the grains exhibiting their angles blunted, and having aſſumed a globoſe figure.

This ſand is not confined to Iſchia; it is likewiſe found, in conſiderable quantities, on the ſhore of Pozzuolo. But what is its origin? It is certain that this iron could not thus have cryſtallized without having a baſe, or point of ſupport; and, in the volcanized countries, no ſubſtance preſents itſelf more proper for ſuch a baſe than the lava, on and within which it has aſſumed this configuration: but it muſt be allowed that this lava has been deſtroyed by length of time, ſince, among the innumerable ſpecimens I have obſerved in theſe countries, I have not

not found one which exhibited ſimilar martial cryſtals.

While making the circuit of this iſland, I continually had in my recollection the opinion of thoſe naturaliſts who, as I have mentioned above, maintain that the formation of priſmatic lavas owes its origin to the ſudden immerſion of the flowing lava into the water. I could not have wiſhed a better opportunity to form a judgment on this hypotheſis, than I here found; where a multitude of currents of lava, in different directions, appear to have ruſhed into the ſea, in which they are ſtill viſible to a conſiderable depth. But I did not meet with one that had aſſumed any ſuch regular form, or any other reſembling it; either among the lavas above the water, thoſe which touch its ſurface in their deſcent, or thoſe immerſed within it, as far at leaſt as the eye could diſcern.

From the obſervations I made while coaſting this little iſland, I was likewiſe ſtrongly

ſtrongly induced to doubt of a fact expreſsly aſſerted by M. Andria, in theſe words: "The lavas, in ſome places near the ſea ſhore, are found full of holes made by the pholades; at leaſt I am of opinion they are to be attributed to thoſe animals, though I could not find in them any fragments of their ſhells."

He then immediately proceeds to reaſon on this fact. "It is manifeſt that the pholades were directed by inſtinct to make their lodgments here; but they could not do this till after a long time, when the lava was become fixed and ſolid."

I ſhall not venture expreſsly to contradict this aſſertion, as I was not able to examine the whole ſhore of Iſchia; and, even if I had examined it, I ſhould ſtill have diſtruſted my reſearches; ſince I could not have been certain that I had explored the preciſe places of which he ſpeaks, as they are not diſtinctly deſcribed. I ſhall only candidly ſay, that I greatly fear there is ſome

miſtake, ſince I never met with any lavas, or other volcanic ſubſtances, which had been made the habitation of the pholas, whether by that name he underſtands the *mytilus lithophagus*, or the *pholas dactylus* of Linnæus. In my reſearches relative to marine animals, I have given particular attention to thoſe which pierce and inhabit ſub-aqueous ſtones. I have examined, with the utmoſt care, the volcanic ſubſtances of Etna, which are bathed by the ſea, thoſe of the Eolian iſles, and ſome of thoſe of Veſuvius. Nothing is more frequent than to find on theſe, various kinds of teſtaceous animals, as oyſters, ſerpules, lepades, and various others of the ſame ſpecies; but I never found them pierced by pholades, or any other animals which corrode foſſil ſubſtances. I have found theſe animals in places not volcanic, though not in all, as I have obſerved that they never make their lodgements but in calcareous ſtones, of which kind the Iſchian lavas, and, in general, other lavas, are not. I therefore incline to ſuſpect that ſome other cavities, reſembling

thoſe which are the work of the pholades, have deceived M. Andria. I could at leaſt wiſh that he would aſcertain the fact by repeating his obſervations on the ſpot, as, ſhould it be eſtabliſhed, it would, in my opinion, be the only example of the kind ever diſcovered in volcanized ſtones.

I employed three days in examining this iſland; and, during my reſearches, carefully obſerved whether I could diſcern any ſmoke or vapour ariſing from the ground, whence it might be concluded that the volcanic conflagrations were not entirely extinguiſhed; but I could not diſcover the leaſt appearance of the kind, nor had any been obſerved by the oldeſt inhabitants of the vicinity, of whom I made the moſt careful enquiries. The ſtoves of Iſchia may, however, induce us to be of a contrary opinion. It is well known that theſe ſtoves are filled with warm aqueous vapours, which continually iſſue from cracks and fiſſures in the lava, and which, though they have ſome of the noxious qualities common to volcanic

exhalations, are extremely beneficial in many diſorders. Theſe certainly can only be produced by a heat which, whatever may be the cauſe of it, raiſes the ſubterraneous water in vapour.

This iſland, when it was firſt produced by conflagrations in ancient, and, to us, unknown times, muſt have been of much greater extent than it is at preſent. The ſouthern ſide, expoſed to a ſea which beats againſt it without any interpoſing obſtacle, and formed in many places of tufa, one of the leaſt hard of volcanic ſubſtances, muſt have been conſiderably worn away and diminiſhed; and this diminution muſt continually increaſe. Time, which changes and deſtroys every thing, has likewiſe produced a great alteration in the interior parts of the iſland. From the ſummit of Epopeo, we diſcover a number of conical eminences; but their internal craters no longer exiſt, nor do we find in Iſchia inconteſtible traces of a ſingle one, ſince thoſe depths and ample cavities, thoſe reſemblances

blances of theatres and amphitheatres, which we obſerve around us, may be equally the effect of fire or water.

I ſhall conclude theſe obſervations by an important reflection on the volcanic materials of Iſchia. Theſe are different from thoſe of the other Phlegrean fields. Except the mountain Veſuvius, the extenſive plain on which the city of Naples ſtands, the ſurrounding hills to the north, the north-weſt, and the weſt, the craters of the lakes Agnano and Averno, many parts of Solfatara, Monte Nuovo, the promontory of Miſeno, Procida, &c. they are the reſult of tufaceous ſubſtances. Theſe are, in fact, not wanting in Iſchia; but the predominant part of its compoſition is various kinds of rock, and principally the horn-ſtone. The eruption of the Arſo, likewiſe, which is the laſt conflagration of which we have any knowledge, is compoſed of the ſame ſtone. The ſubſtances, therefore, which have furniſhed aliment to the different conflagrations of Iſchia, have had their centre in thoſe argillaceous

rocks, which by the above-mentioned eruption in 1302 ſhewed that they were not then exhauſted.

Theſe rocks, as we have ſeen, abound in cryſtallized feltſpars, which, in the furnace, exhibit a quality we rarely meet with in the feltſpars of other lavas ſubjected to the ſame degree of heat. I mean their fuſibility. If we except thoſe of the Arſo, which do not yield to the fire, all the feltſpars of theſe lavas may be perfectly liqueſied. The lava, in which the feltſpars are contained, acquires a clear colour, and becomes ſlightly tranſparent; while in other parts it preſents an opaque and imperfect enamel. If the quantity of the feltſpars included is more than double that of the lava, the product which reſults is a true glaſs, but ſomewhat leſs tranſparent than factitious glaſs; but when the feltſpars are ſolitary, and not at all injured by the lava, like thoſe of the Calle di Panza, the glaſs is perfect and extremely tranſparent. It has no colour, is very compact, and gives ſparks ſtrongly with ſteel.

To

To bring it to this perfection, it requires a fire of about two days. At the end of the firſt day, the feltſpar is only reduced to a paſte, ſimilar to porcelain; the pieces then conglutinate together; many exhibit a ſemi-vitrification, and the ſurface within the crucible is not horizontal and even, but has riſings and cavities, according as the pieces have been put in: by continuing the fire, however, it becomes level and ſmooth.

The proſecution of theſe experiments induced me to attempt to fuſe, with the ſame degree of heat, two other feltſpars which are not from volcanic countries; the one being from Mount St. Gothard, and the other from Baveno. Father Pini has the honour of their diſcovery. The firſt is in maſs, of a ſhining white, foliated, and very hard. I kept it in the furnace during eight-and-forty hours, but it had only contracted a ſlight ſuperficial vitreous appearance. When placed within two crucibles joined by their tops, with charcoal entirely ſurrounding them, in a furnace, the fire of which was violently excited by the

bellows for two hours, the angles of this feltſpar became blunted, and the pieces attached together, contracting a ſmooth ſurface, and a milky whiteneſs, but without any ſenſible fuſion taking place in the internal parts.

The other feltſpar, from Baveno, is cryſtallized in tetrahedrous priſms, opaque, leſs hard than the former, and of a reddiſh yellow colour. After continuing forty-eight hours in the furnace, a ſlight conglutination took place in the pieces, which had acquired a ſnowy whiteneſs.

On comparing theſe two feltſpars and others contained in innumerable lavas, with thoſe of the Iſchian lavas, we may conclude that it is very rarely that the fuſion of theſe ſtones can be obtained by the utmoſt heat of a glaſs furnace.

From theſe obſervations on the lavas of Iſchia we likewiſe learn another truth. Mineralogiſts have ſaid that ſhoerls are more eaſily

eaſily fuſible than feltſpars; becauſe they have obſerved that the degree of heat in which the former fuſe is inſufficient to fuſe the latter. But I have experienced that this aſſertion is not always true; and it will be ſeen in the courſe of this work, that the ſhoerls of ſome lavas will reſiſt the ſame degree of heat in which the feltſpars of Iſchia are completely fuſed. The cauſe of this may be, either that the ſilex ſometimes is leſs abundant in the feltſpars than in the ſhoerls, or that their component principles are proportioned in ſuch a manner, that the fuſion of ſome is facilitated more than that of others, or becauſe they contain more iron, it being well known that this metal promotes the fuſion of ſtones.

CHAP.

CHAP. VI.

THE VALLEY OF METELONA, NEAR CASERTA.

The tufa found in this valley, compoſed of fragments of pumice ſurrounded by calcareous earths—Pieces of enamel mixed with it—This tufa different from other volcanic tufas—Probability that it communicates with the volcanos of Naples and its environs, and perhaps alſo with thoſe of the Agro Romano and Tuſcany—Means propoſed to aſcertain whether the Bay of Naples be the remains of an ancient volcanic crater, and to what diſtance within the ſea the roots of Mount Veſuvius and thoſe of Iſchia extend.

AN excurſion from Naples to Caſerta, and thence to the neighbouring aqueducts, furniſhed me with an opportunity for new volcanic

canic obſervations. Some miles before we arrive at the ſmall city of Caſerta, ennobled by the ſuperb royal palace, which may be ſaid to conſiſt of four grand palaces united in one by the hand of a maſter, we meet with calcareous earth, which continues to the aqueducts, diſtant ſix miles from that city, and which are a prodigy of art. They conſiſt of a large and magnificent bridge, of the aſtoniſhing length of two miles, and of a proportionate breadth. Within this bridge runs a wide canal, brought from a mountain at the diſtance of twenty-ſix miles, which, paſſing through ſubterranean conduits, ſkirts the ſide of the hill, and deſcends to Caſerta, near the Royal Gardens. As the neighbouring mountains abound in calcareous ſtone, I was not ſurpriſed to find the pavement of the bridge formed of that ſtone; but it ſomewhat excited my attention when I perceived that the remainder of the edifice was conſtructed with volcanic tufa. in which are mixed ſome pieces of enamel. Sir William Hamilton has told us, that in the environs of Caſerta, below a ſtratum of vegetable

table earth four or five feet in thickneſs, we meet with cinders, pumices, and fragments of lava; and that, on digging near the foundations of the above-mentioned aqueducts, volcanic earths are diſcovered. I therefore firſt conjectured that the tufa had been procured from theſe ſubterranean places; an opinion in which I was confirmed by obſerving that the whole country round was calcareous, not excepting the higheſt mountains, which were, nearly all, of the ſame contexture and colour with the chains of hills between Naples and Loretto. One of the inhabitants of this part of the country, however, aſſured me that this tufa was dug from a plain, about a mile diſtant to the north, called the *Valley of Metelona*, of which I was convinced, on repairing to the ſpot. This tufa, in ſeveral places, lies in heaps on each ſide of the public road, principally near the *Taverna*, where we find the excavations, not within but above the ground, which have in part ſupplied materials for theſe aqueducts. This tufa is extremely porous, and being immerſed in water attracts it forcibly,

and

and with a ſlightly hiſſing ſound, as is the caſe with other bibacious bodies. Like tufas in general, it has a moderate weight and conſiſtence, is rough to the touch, and inclines to a yellow colour. But, on a more minute examination, it diſcovers its original, and is found to be compoſed of a mixture of ſmall fragments of pumice, and any piece of it detached from the maſs will be found to contain fragments of that ſtone. It appears as if compoſed of ſmall threads extended lengthwiſe, which viewed with the lens are found to be ſlender filaments, extremely friable, and generally parallel to each other. It contains many cavities, within which the pumice appears changed into vitreous balls; we likewiſe find little globes of pumice, which have an external vitreous coat, but which, within, have preſerved their fibrous nature: laſtly, in ſome parts of this tufa are contained pieces of ſolid enamel, extremely friable, ſhining, and in their fractures reſembling aſphaltum.

The tufa now deſcribed is of a ſingular quality;

quality; at leaſt, in my travels through the Two Sicilies, I have not found any reſembling it. The others are, uſually, of an argillaceous baſe; this, as has been ſaid, is a compoſition of fragments of pumice. Hence we may eaſily conceive that the reſults produced by the furnace muſt be different. The tufa of Metelona afforded a true enamel, but the others remained infuſible.

The edges of the tufa, or rather of the broken and half pulverized pumices, are ſurrounded with calcareous ſtone. There is, however, no doubt that theſe pumices, beſides having deep roots, extend likewiſe laterally among the ſtone to a great diſtance. Theſe volcanic matters have probably an immediate communication with the volcanos of Naples and its environs, as alſo with thoſe of the Agro Romano, and perhaps alſo with thoſe of Tuſcany, ſo as to form a ſoil entirely volcanized, of immenſe extent.

Some have conjectured, and perhaps not without reaſon, that the great baſon of the ſea,

ſea, called the bay of Naples, in front of Capri, is the remains of an ancient volcanic crater. It would contribute to the advancement of natural knowledge, were the bottom to be explored, at various diſtances from the ſhore, by the means of ſuch inſtruments as are employed to fiſh up coral, and, ſometimes, pieces of the rock on which it grows. Should we by ſuch means diſcover a cavity ſimilar to an inverted funnel, or draw up ſubſtances from the bottom, which ſhould be known to owe their origin to fire, this conjecture would become a well-founded opinion.

A portion of the roots of Mount Veſuvius are bathed by the ſea. Who can ſay how far theſe roots may extend under the water? The ſame may be remarked of Iſchia, which, perhaps, as ſome have conjectured, was anciently joined to Procida: it were to be wiſhed that we could obtain facts that might aſcertain the truth of ſuch conjectures. It is well known how far Sir William Hamilton has extended the limits of the volcani-

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zation of the Phlegrean fields, by land; and there is no doubt but they might be ſtill more enlarged by ſea. The experiments neceſſary for this are certainly difficult, but not impoſſible. The induſtry of two Italians of merit, the Count Ferdinando Marſigli, and Vitaliano Donati, has made us acquainted with the nature of the bottom of ſome parts of the Mediterranean, and the Adriatic. In the courſe of this work I ſhall ſtate what I have obſerved relative to the bottom of the famous ſtrait of Meſſina, and that in which the channels that ſeparate the Eolian iſles terminate. It is greatly to be wiſhed, for the advancement of volcanic knowledge, that the bottom of the ſea near Naples, and the adjacent places, might be explored by ſimilar experiments.

CHAP.

CHAP. VII.

JOURNEY TO MOUNT ETNA.

Compariſon between Veſuvius and Etna—The lavas of the latter volcano begin to appear, from the ſea, at the diſtance of thirty-ſeven miles from Meſſina—Different epochs of the flowing of theſe lavas—Modern Catania almoſt entirely built of lava; as was the ancient city, which was deſtroyed by an earthquake in 1693—*Remarks on the obſervations of Mr. Brydone, relative to Etna—Uncertainty of the opinion of Count Borch, that the age of the lava may be calculated by the quantity of vegetable earth produced by time—Fruitleſs attempts to render cultivable the eruption of* 1669—*The thinneſs of the cruſt of vegetable earth; the cauſe of the fertility of the lower region of Etna—Monte Roſſo—Eructation of its lavas—Abundance of ſhoerls on this mountain—*

Chemical analyſis of theſe ſhoerls—Feltſpars not always more difficult to fuſe than ſhoerls—View from Monte Roſſo of the whole current which, in 1669, *flowed into the ſea—Calamities ſuffered, at different times, by St. Niccolo dell Arena from the eruptions of Etna—Lavas of the middle region—Its great celebrity for luxuriant vegetation, and the loftineſs of its trees—Great antiquity of theſe two regions—Grotta delle Capre—Nature of the lavas of that grotto.*

THOUGH Veſuvius, conſidered in itſelf, may be juſtly called a grand volcano, and though, from the deſtruction and calamities it has at various times occaſioned, it has continually been an object of conſternation and terror to the inhabitants of the neighbouring country; yet when it is compared with Etna it muſt loſe much of its celebrity, and appear ſo diminiſhed, that, if the expreſſion may be allowed, it may be called a volcano for a cabinet. Veſuvius does not, perhaps, riſe higher than a mile above the level of the ſea; and the whole circuit of its baſe, including

including Ottajano and Somma, is not more than thirty miles; while Mount Etna covers a ſpace of one hundred and eighty, and in its height above the ſea conſiderably exceeds two miles. From the ſides of Etna other leſſer mountains riſe, which are as it were its offspring, and more than one of which equals Veſuvius in ſize. The moſt extenſive lavas of the latter mountain do not exceed ſeven miles in length; while thoſe of Etna are fifteen or twenty, and ſome even thirty miles in extent. The borders of the crater of Mount Etna are never leſs than a mile in circuit, and, according to the changes to which they are ſubject, ſometimes two or three miles; it is even reported, that in the dreadful eruption of 1669 they were enlarged to ſix *. But the circumference of the Veſuvian crater is never more than half a mile, even when wideſt diſtended, in its moſt deſtructive conflagrations †. Laſtly, the earthquakes occaſioned

* Borelli, Hiſt. Incend. Ætnæ, an. 1669.

† I know not how M. Sage was led into ſo ſtrange an error as to aſſert that *the crater of Veſuvius is more*

 than

ſioned by the two volcanos, their eruptions, ſhowers of ignited ſtones, and the deſtruction and deſolation they occaſion, are all likewiſe proportionate to their reſpective dimenſions. We cannot therefore wonder that viſits to Veſuvius ſhould be conſidered as undertakings of little conſequence, and never be made public, except lavas ſhould have been flowing at the time; while a journey to Etna is conſidered as no trivial enterpriſe, both from the difficulty of the way, and the diſtance; as from Catania, whence it is uſual to ſet out, it is thirty miles to the ſummit of Etna. On ſuch a journey, likewiſe, we have to paſs through three different climates; whereas to go from Naples to Veſuvius ſhould be rather called an excurſion than a journey. We find alſo little difference between the temperature of the air at the bottom of this latter mountain, and that of its ſummit. Notwithſtanding theſe difficulties, however, the

than three miles in diameter. (Elem. de Min. tom. 1.) Were this true, the circumference of the Veſuvian crater muſt be nearly ten miles, an extent which perhaps the crater of no volcano in the world ever had.

gigantic

gigantic majeſty of the Sicilian volcano, its ſublime elevation, and the extenſive, varied, and grand proſpects its ſummit preſents, have induced the curious, in every age, to aſcend and examine it; and not a few have tranſmitted to poſterity the obſervations they have made during their arduous journey.

Theſe examples would alone have ſtrongly excited me to make the ſame journey, and ſimilar reſearches; but I had alſo a ſtill more powerful incentive in the undertaking in which I had engaged to travel through the Two Sicilies, in order to make obſervations on the volcanos, among which Etna muſt principally claim my attention, as being the largeſt and moſt ſtupendous of all that are, at preſent, in a ſtate of conflagration on the ſurface of the globe. I was, likewiſe, induced to believe that, notwithſtanding ſo many journeys to this mountain have already appeared, I might ſtill publiſh mine; and that for ſeveral reaſons. Firſt, becauſe I flatter myſelf that I ſhall be able to ſtate ſome obſervations which will be, in part at leaſt, new

to the reader; ſecondly, becauſe I ſhall thus have an opportunity to examine many things related by the travellers who have preceded me, which do not always appear to bear the ſtamp of truth; and laſtly, becauſe my remarks may furniſh ſubjects for uſeful diſcuſſion.

I took my departure from Meſſina for Catania, a diſtance of ſixty miles, by ſea, in a ſmall veſſel, coaſting cloſe upon the land, all the way, to examine the ſhore. On the 1ſt of September, I landed, at the diſtance of fifteen miles from Meſſina, on a part of the ſhore which forms there a head-land, where mariners are accuſtomed, ſometimes, to make a ſhort ſtay. The ſhore here was entirely of calcareous earth, except ſome pieces of ſcattered detached lava. The latter production excited in me ſome doubts whether the exploſions of Etna had ever reached to ſo great a diſtance; but the mariners who were with me aſſured me, that theſe pieces of lava had been brought from the ſhore of Catania by veſſels who had taken them in as ballaſt, and left

them

them here when they had no farther occaſion for them, in conſequence of having taken in other lading. Of the truth of this account I was afterwards ſatisfied, as I found this lava perfectly ſimilar to that in the neighbourhood of Catania.

The real eruptions of this volcano begin firſt to appear, in the form of rocks of different elevations, which overhang the ſea, at the diſtance of thirty-ſeven miles from Meſſina, on the way to Catania; and at the ſame diſtance Etna is faintly ſeen to ſmoke, and majeſtically raiſes its head above the other mountains of Sicily. We had a clear view of it, the ſky being free from clouds; and I began to entertain a hope that I ſhould be able to viſit its higheſt ſummit, ſince it was not, as it frequently is, covered with ſnow.

Before we arrived at Catania, I landed at ſeveral places, to examine the ſhore, which is entirely formed of lava. I was particularly attentive to its courſe and changeable ſtructure. The greater part of the lavas

proceed in a right line from the body of Mount Etna, with various inclinations to the level of the ſea; and many of them, having been broken by the violent ſhocks of the waves, exhibit their various ſtratification, and ſhew the different epochs in which they have flowed, by the difference of their ſtrata, and the coatings of vegetable earth more or leſs thick interſperſed between thoſe ſtrata.

All theſe lavas, at leaſt thoſe which I examined, are ſimilar with reſpect to their baſe, as they all derive their origin from the hornſtone, and all contain within them feltſpar-cryſtals.

I employed two days in this coaſting voyage from Meſſina to Catania. The materials of which the latter city is built are ſuch as might be expected in a volcanized country, where ſtones of any other than a volcanic nature are not to be found but at a conſiderable diſtance. The edifices, both public and private, and even the walls of the city, are principally of lava; which has furniſhed

niſhed materials not only for the modern Catania, but alſo for that more ancient city, which was entirely deſtroyed by an earthquake in the year 1693; at leaſt its ruins when dug up have all been found to conſiſt of lava. We learn likewiſe from obſervations anterior to that fatal period, that lava has been met with under its foundations on the occaſion of digging for wells *; nor is it poſſible for us to ſay to what depth the roots of the Etnean eruptions extend. If we only take a view of the ſurface of the territory of Catania, we every where meet with immenſe accumulations of lava, among which the moſt conſpicuous are the remains of that torrent which poured from one of the ſides of Etna in 1669, inundated, with wide-ſpreading ruin, a ſpace of fourteen miles in length, and nearly four in breadth, roſe over the walls of Catania, burying under it a part of the city, and at length precipitated itſelf into the ſea.

It would be a ſuperfluous labour were I to

* Borelli, ubi ſup.

proceed

proceed to give a long and minute deſcription of this torrent of lava, which has been already ſo amply deſcribed by Mr. Brydone*, Count Borch †, Sir William Hamilton ‡, and Riedeſel §; though I cannot ſay that the relations of four travellers, who repeat the ſame things after each other, were much wanted; ſince our illuſtrious countryman, the Italian Alphonſus Borelli, who was preſent at the time when this dreadful torrent of fire burſt forth, wrote a work expreſsly to deſcribe it ‖. It appears to me preferable to

* Tour through Sicily. † Lettres ſur la Sicile.

‡ Campi Phlegræi. § Travels in Sicily.

‖ Mr. Brydone is the only one of theſe travellers who mentions Borelli. He cites four obſervations from him; but perverts them, to give them more an air of the marvellous.

He ſays, firſt, that according to the teſtimony of Borelli, " after the moſt violent ſtruggles and ſhakings " of the whole iſland, when the lava at laſt burſt " through, it ſprang up into the air to the height of " ſixty palms."

Mr. Brydone I hope will pardon me, when I tell him that Borelli, here, certainly only ſpeaks of ſome local ſhocks, and tremblings of certain places in the vicinity of

to preſent the reader with the view, with ſome improvement which this celebrated Phyſician

of the volcano, and by no means of a ſhaking felt over the whole iſland.* As for the lava ſpringing up into the air to the height of ſixty palms, there is not a word about it in the whole book.

Mr. Brydone, likewiſe, makes Borelli ſay, that "for "many weeks the ſun did not appear, and the day "ſeemed to be changed into night."

But all we find in Borelli's account, relative to this darkneſs, is, that "on the 8th of March, an hour before "ſun-ſet, the air, in the ſuburb of Pidara, and ſome "other neighbouring places, became ſomewhat thick "and dark, with a darkneſs ſimilar to that which is "cauſed by ſome partial eclipſes of the ſun."

The two other paſſages, which I omit for the ſake of brevity, are equally perverted.

Mr. Brydone, indeed, through his whole journey to Etna has ſufficiently ſhewn his attachment to the marvellous, and, where that has failed him, has had recourſe to the aid of his playful fancy to furniſh him with extravagant, though ingenious, inventions of the ridiculous kind. The ſtory of the veil of St. Agatha is an example; which veil, according to him, the people of Catania conſider as an infallible remedy againſt volcanos, but which at the time of a great eruption "ſeemed to have loſt its virtue; the torrent burſting "over the walls, and ſweeping away the image of "every ſaint that was placed there to oppoſe it." But

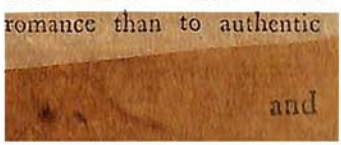
would

Phyſician of Naples cauſed to be taken on the ſpot, at the time, and which in the moſt natural manner repreſents this river of fire, ſuch as it appeared at its beginning, during its progreſs, and at its end; it will likewiſe render much more intelligible ſeveral particulars of which I propoſe hereafter to treat. (See Plate I.)

Having mentioned theſe travellers, I ſhall make ſome obſervations on what has been ſaid by Count Borch relative to the changes that have taken place in the lava of 1669,

would it not have been more commendable to have furniſhed his readers with real information, inſtead of filling ſo many pages with theſe trivial and inſipid pleaſantries? In fact, after having read his five letters on Etna, what idea do they enable us to form of the nature of this mountain?

I do not mean, by what I have ſaid, indiſcriminately to condemn the whole work of Mr. Brydone. His Tour frequently contains facts and obſervations well deſerving attention. It is elegantly written, and the author was well acquainted with the ſecret of exciting our curioſity, and rendering his narrative intereſting; though frequently, with that kind of intereſt which ſeems more ſuitable to romance than to authentic hiſtory.



and thoſe of ſome other eruptions preceding, and poſterior to, that time. Theſe changes conſiſt in the vegetable earth which begins to appear on them, generated in part from the decompoſition of the lava, and in part from the deſtruction of the plants, which, after a certain time, are produced upon it. From the quantity of this earth he deduces a rule to judge of the age of the lava; which he endeavours to prove by examples of different Etnean lavas, of various epochs, which are covered with more or leſs of this earth in proportion as they are more or leſs ancient. Thus, a lava produced by an eruption in 1157, when he examined it in December 1776, had a coating of earth twelve inches thick; another which had flowed in 1329, had one of eight inches; on that of 1669, was found more than one inch; while the moſt recent, that of 1766, was entirely deſtitute of ſuch earth. Whence he concludes, that, from the antiquity of the lavas, aſcertained by the quantity of earth with which they are covered, may be deduced the antiquity of the world.

As

As this argument is certainly ſomewhat ſpecious, and has been employed by others, it merits to be diſcuſſed. We undoubtedly know from repeated obſervations, that lavas, after a ſeries of years, are inveſted with a ſtratum of earth proper for vegetation; and the fact has already been proved in this work: nor can it be denied that this earth is originally produced by the decompoſition of the lavas, and that of the plants which have taken root upon it. The ſame may be obſerved in mountains not volcanized, the ſtones of which (at leaſt very frequently), being long expoſed to the action of the air and ſeaſons, are reſolved into an earth proper for the growth of vegetables. It would not, therefore, admit of a doubt that the more ancient lavas muſt afford a greater quantity of earth than thoſe of more recent date, were every exterior circumſtance equal; were they all of the ſame conſiſtence and qualities, and all equally affected by the fire. But how greatly they differ in theſe reſpects we have already ſeen, and ſhall ſee ſtill more in the progreſs of this work. Such differences,

therefore, muſt render the argument of Count Borch extremely inconcluſive; ſince a lava of an earlier age may have much leſs earth than one of later date; a circumſtance which the Chevalier Gioeni told me he had frequently obſerved in ſeveral of the lavas of Etna.

Among the lavas adduced by Count Borch, in favour of his hypotheſis, is that which flowed in 1329, which, when he examined it, that is four hundred and forty-ſeven years after its eruption, was covered with eight inches of earth. Yet the lava of the Arſo, in Iſchia, which ruſhed into the ſea in 1302, when I ſaw it in 1788, ſtill preſerved in every part its hardneſs and ſterility *.

It appears, likewiſe, extraordinary, that this writer ſhould not have noticed the remains of another current of lava near Catania, which has been employed for two thouſand years as materials for buildings, and which retains ſuch hardneſs, that where the labour of

* Chap. V.

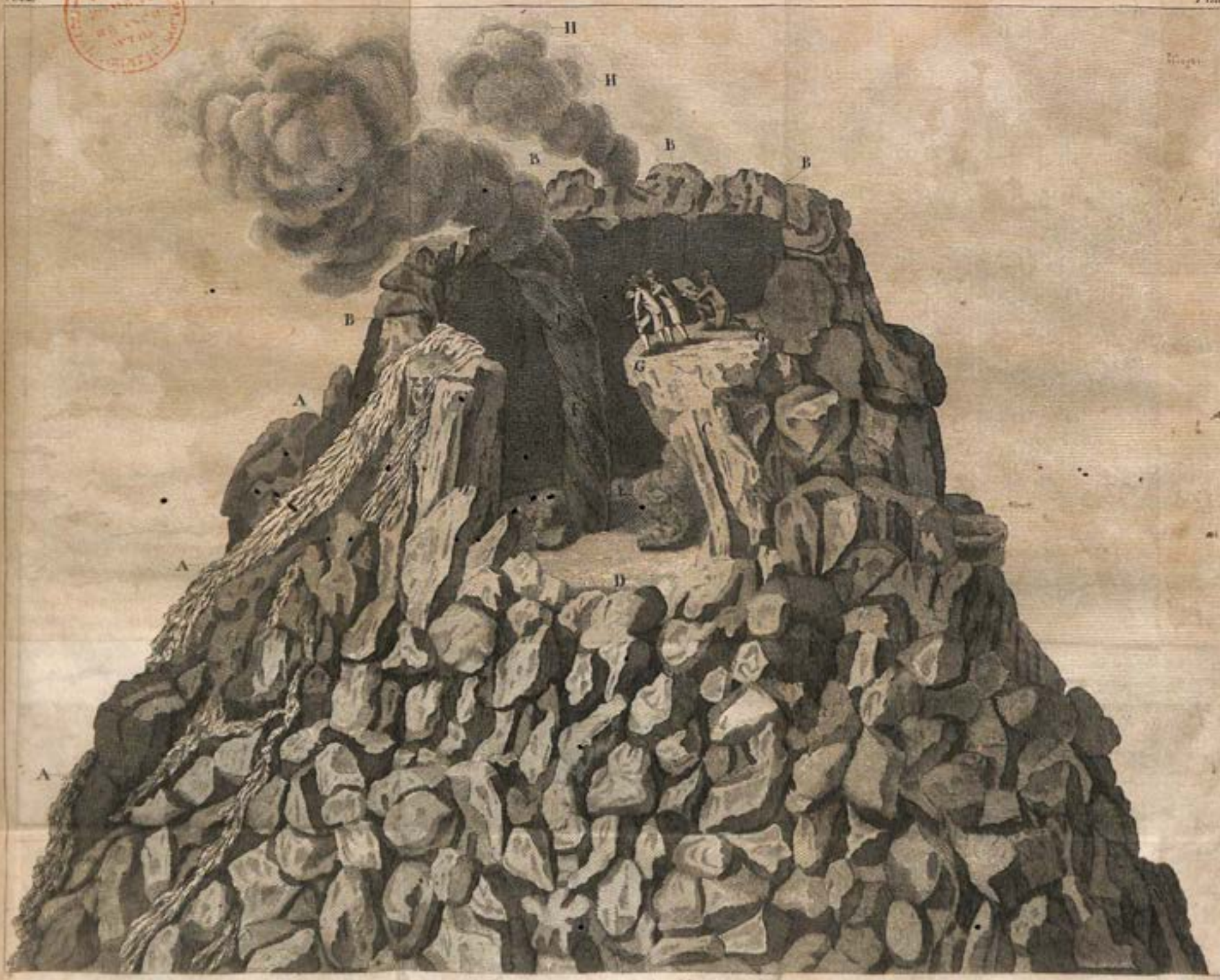
the

the cultivator has not been exerted it ſtill continues entirely ſterile.

With reſpect to the lava of 1669, I cannot conceive how the Count could attribute to it an inch or more of earth, ſince it is entirely deſtitute of it. Were this the fact, the ſurface of the lava muſt at leaſt, in ſome few places, exhibit ſome blades of graſs, or ſmall plants, as a ſtratum of earth an inch thick would be ſufficient to nouriſh them; but we find it, on the contrary, deſtitute of every vegetable, except a few lichens, which we know will take root and grow on the hardeſt bodies, and ſuch as entirely reſiſt all effect of the air, as quartzes, and even on the ſmooth and ſlippery ſurface of vitreous ſubſtances. The Count, very poſſibly, examined this lava in low hollow places, into which the rain-water had drained, and brought down with it ſome particles of earth, that might have formed a thin ſtratum *.

* With reſpect to the uncertainty and fallacy of any calculations deduced from the greater or leſs quantity of vegetable earth which may cover lavas, the reader may conſult the work of M. Dolomieu above cited.

Before



The Summit of Mount Etna.

Before I travelled into Sicily, I had read the eulogiums beſtowed on the Prince of Biſcaris, by Count Borch, among other reaſons, becauſe he had exerted himſelf in attempts to change the face of the lava of 1669, and transform the ungrateful ſoil into a fruitful garden. When I arrived in the iſland, I admired the effect of human art. In many places the hardeſt lava had been opened by the force of mines; while in others it had been broken into extremely minute fragments, into which, when collected in certain receptacles, ſeveral kinds of uſeful plants had been inſerted: but, unfortunately, they always periſhed, though they were repeatedly planted. Some few I found living, as here and there a pomegranate or an almond tree; but theſe were extremely weak and languid, though the broken lava among which they had taken root was mixed with vegetable earth. A ſpecies of the Indian fig*, alone, throve and flouriſhed; but it is well known that this ſhrub delights in lavas, and

* Cactus opuntia. Linn.

that it will take root, grow to a conſiderable height, and bear fruit plentifully, on the moſt ſterile. In the courſe of this work I ſhall have occaſion to treat more at length on this ſubject. At preſent there only remains a large pond which has been dug in the lava of a conſiderable depth, and communicating with the water of the ſea, in which are preſerved different kinds of fiſh.

After having, for a conſiderable time, examined the environs of Catania, aſſiſted by the Chevalier Gioeni, to whom I owe the moſt lively and ſincere gratitude for numerous favours; I ſet out for Mount Etna, on the morning of the 3d of September, accompanied, among others, by Carmelo Puglieſi, and Domenico Mazzagaglia, two guides extremely well acquainted with the roads. I performed the greater part of the journey on foot, only riding when I found myſelf fatigued. I think it ſcarcely neceſſary to mention, what has been ſo often repeated by travellers, and therefore muſt be ſo well known, that the lower region of Mount Etna, which extends through

through twelve miles of the aſcent towards the ſummit, is incredibly abundant in paſtures and fruit trees of every kind *.

It is alſo well known that this fertility is to be aſcribed to the lava, which, ſoftened by length of time, has produced a moſt fertile ſoil, thus compenſating paſt calamity by preſent fruitfulneſs. To this, however, the induſtry of man and arts of agriculture have not a little contributed; as well as the corruption and decompoſition of vegetables, which have ſo great a ſhare in the fructification of the earth. Theſe lavas, however, in ſome places, ſtill manifeſt their native

* The fertility of this region has been celebrated by the greater part of thoſe authors who have written concerning Etna; among which the moſt diſtinguiſhed are Strabo, and Fazello, but above all Peter Bembo, who, after having viſited the mountain, compoſed an ingenious dialogue on the ſubject. It may excite ſome ſurpriſe, that, after ſo many deſcriptions of this region, and after Borelli, above a century before, had thought ſuch a deſcription ſuperfluous; Mr. Brydone ſhould imagine it worth while once more to recount the prodigies of this fertile ſoil.

wildneſs, riſing above the uſeful ſoil, in craggy points and tumours, or diſcovering their naked ſides on the banks of rapid torrents. On ſome declivities, where the earth has but little depth, we find trees, the roots of which, not having been able to penetrate the unyielding lava, have turned aſide, and extended horizontally along the ſurface of the ſoil. Whence it evidently appears that the fertility of the inferior region depends entirely on a cruſt of earth, more or leſs thick, without which the ſame barrenneſs muſt take place, which, it cannot be doubted, once prevailed.

At ten in the morning, I arrived at the village of Nicoloſi, (Plate I. H.) near Monte Roſſo, which formerly was a plain, when in 1669 a new vortex opened, and diſgorged a dreadful torrent of lava, which poured headlong down until it reached the ſea, where it formed a kind of promontory (Y). It would have been a great omiſſion not to have viſited this mountain, though it lies a little out of the

the direct road up Etna. Beſides the memorable eruption which has been mentioned more than once, other objects relative to it, which I had here an opportunity of examining on the ſpot, attracted my attention. Among theſe, was that quantity of black ſand which was thrown out in that eruption from the new volcanic mouth, which ſtill remains, and covers an extenſive plain beyond Nicoloſi, where once verdant trees flouriſhed; ſome of which ſtill preſerve remains of life, and raiſe their leafy branches above the changing ſand. This ſand, which covers a circuit of two miles round Monte Roſſo, when it was firſt ejected from the vortex, extended over a ſpace of fifteen miles; and covered the ground to ſuch a height, that the vines and ſhrubs were entirely buried. Some of the finer particles of it were carried by the ſoutherly wind even to Calabria, where they fell thick in many places, as we are informed by Borelli.

As I approached the mountain, I found the depth of the ſand greater, and it became

a conſiderable impediment in my way, as my leg frequently ſank into it up to the knee. It is well known that this mountain is forked, being ſo formed by the eruption, at which time it was called by the country people, Monte della Ruina (the Mountain of Ruin), and afterwards Monte Roſſo (the Red Mountain); probably becauſe ſome parts of it appeared of that colour. Borelli tells us, that its circumference at the baſe does not exceed two miles, and that its perpendicular height is not more than one hundred and fifty paces; while Sir William Hamilton eſtimates its height at a mile, and its circuit at leaſt at three. From the obſervations I have been able to make, I muſt prefer the eſtimate of the Italian mathematician to that of Sir William.

The accurate accounts of the ſame Borelli inform us, that the gulf whence this eruption iſſued opened on the 11th of March, 1669, about the time of the ſetting of the ſun; that the lava burſt forth that ſame night; and that, on the 13th of the ſame month, a ſhower

ſhower of ſcoriæ and ſand began to be caſt into the air, which continued three months, and formed Monte Roſſo. From among a hundred or more mountains which rear their heads on the ſides of Mount Etna, this is the only one with the hiſtory of the formation of which we are acquainted *.

On examining this bifurcated mountain at the top, on the ſides, and at the bottom, eſpecially in thoſe places where the rain-waters had produced furrows and deep excavations, I found it compoſed of different ſcoriæ and ſand, that is to ſay, lava that had undergone various modifications, and from

* Sir William Hamilton, in his journey to Etna, ſpeaking of this eruption, cites an account of it by the Earl of Winchelſea, who was preſent at the time, but which is more marvellous than true. He did not approach the place, but only beheld the eruption from the towers of Catania. He tells us, that the fire divided one mountain into two; and that it was compoſed, as were the ſtones and aſhes vomited out (beſides other principles), of mercury, lead, bronze, and every other kind of metal; which alone would be ſufficient to deprive this account of all credit.

that ſame lava which has formed the immenſe current; as ſufficiently appears from the identity of their principles. The baſe of this lava is the horn-ſtone: it is of a grey colour, dry in its fractures, rough to the touch, of a grain moderately fine, gives ſparks with ſteel, and ſounds when ſtruck. It ſerves as a matrix to a great number of felt-ſpathoſe and ſhoerlaceous cryſtallizations *. If from this lava we turn our eyes to the ſcoriæ, of which Monte Roſſo is principally compoſed, we obſerve the ſame kind of baſe, containing, in like manner, ſhoerls and feltſpars; except only that the ſcoriæ have more lightneſs and friability, from their greater number of pores, which gives them the reſemblance of certain ſponges; beſides that they have a kind of vitreous appearance, and that the pieces on

* I have given a brief deſcription of this lava, as, in the preſent caſe, it ſeemed neceſſary; but, in future, I do not propoſe to deſcribe the lavas and other productions of Etna; both becauſe a month would not have been ſufficient to have made a proper examination of them all, much leſs the ſhort time I was able to employ in this journey; and becauſe M. Dolomieu has already undertaken to give this deſcription.

the ſurface are ſcabrous; differences which ariſe from the ſcoriæ having been more changed than the lavas by the activity of the fire, and that of the elaſtic gaſes.

When the volcano threw up a deluge of ſcoriæ, a great number of them muſt claſh, be broken, and reduced to powder; thus producing ſhowers of ſand: whence the ſand that covers the environs of Monte Roſſo, which, from the examinations I have made, I find to conſiſt only of triturated ſcoriæ. The lava of Monte Roſſo, the ſcoriæ, and the ſand conſiſt, therefore, of the ſame component parts.

M. Dolomieu having found, at Monte Roſſo, great numbers of detached ſhoerls, of the ſame kind with thoſe which enter into the lava of that current; that is to ſay, black, lamellated, flat, of a hexaedrous priſmatic form, and, for the moſt part, terminated by a dihedrous pyramid, he thought, with apparent reaſon, that they at firſt entered into the body of the lava; he therefore

fore endeavoured to explain in what manner they were ſeparated from it; having recourſe to the ſulphur, which, according to him, had ſcorified the lava, but had not been able to produce the ſame effect on the ſhoerls, from the ſmall quantity of iron they contain, which, conſequently, remained free and detached.

It is incredible how great a number of theſe looſe ſhoerls are to be met with about Monte Roſſo, and particularly on its top. When I was there, the ſun ſhining clear, I ſaw them, in ſeveral places, ſparkling on the ground, and I had only ſlightly to move the ſcoriæ and ſand, to bring them to light by hundreds. They were exactly ſuch as they are deſcribed by the French naturaliſt. I formed a deſign to aſcertain the truth of the theory by which he has endeavoured to explain the ſeparation of the ſhoerls from the lava, and when I returned to Pavia I made ſeveral experiments for that purpoſe. As his hypotheſis was, that it proceeded from the ſhoerls containing a leſs quantity of iron

than

than the lava, it was to be expected that the magnetic needle would be leſs affected by the former than the latter. From the experiments I made both with the lava, or, more properly ſpeaking, its baſe, and with the detached ſhoerls, I perceived that the needle was attracted by the former at the diſtance of $\frac{1}{4}$, $\frac{1}{3}$, and even $\frac{1}{2}$ a line, while the attractive force of the detached ſhoerls acted on it at the diſtance of $\frac{1}{4}$ of a line, $\frac{1}{3}$ of a line, and a whole line; one ſhoerl even gave manifeſt ſigns of attraction at the diſtance of a line and a half. It is ſcarcely neceſſary to remark, that in ſuch experiments every acceſſary circumſtance ought to be equal; that is, the pieces of lava ought to be equal in ſize, and of the ſame configuration with the detached ſhoerls. Theſe experiments prevented my adopting the theory in queſtion, ſince they ſhewed that the martial principle was much more abundant in the ſhoerls than in their baſe; contrary to the hypotheſis of M. Dolomieu. Reflecting, however, on the phenomenon of the iſolated ſhoerls, another mode of explanation occurred to me,

which I ſhall here ſubmit to the judgment of the learned reader.

Experience has ſhewn, that the volcanic fire which melted the lava was incapable of melting the ſhoerls, as they are found within it as completely cryſtallized, with angles as acute, and of the ſame luſtre, as thoſe which are detached among the ſand and ſcoriæ. As they are therefore ſo refractory to the fire, and are, beſides, of a different ſpecific gravity from the lava, it may reaſonably be ſuppoſed that, when the latter was melted, and, in the eruption of 1669, forced by elaſtic vapours to a prodigious height, where it was ſeparated into ſmall particles, numbers of ſhoerls were detached from it, and fell, iſolated, partly within the crater, and partly around it. As theſe ſhowers of fiery lava continued three months, the number of ſhoerls which thus fell detached muſt have been very conſiderable, as we, in fact, find them at preſent.

The reſults produced by the furnace on theſe

theſe ſhoerls when detached are very different from thoſe they exhibit when incorporated with the lava. In the former caſe they are infuſible, though they ſhould remain there ſeveral days. When minutely triturated, indeed, their particles will conglutinate together, but without forming a compact and vitreous body. The fuſion, on the contrary, is perfect in thoſe which are enveloped in the body of the lava. Monte Roſſo, quite to the ſea, abounds in ſuch ſhoerls. A few hours in the furnace are ſufficient to change them into a ſhining, compact, and extremely hard enamel. Some lineament of the feltſpars contained in the lava always remains; but it is impoſſible to diſcover any traces of the ſhoerls, they having formed, with their baſe, which has paſſed into the ſtate of enamel, a ſimilar and homogeneous body. The baſe of this lava, which, as we have ſaid, is of hornſtone, has therefore acted as a flux on the ſhoerls.

This experiment throws light on another ſubject

ſubject of ſome importance, already mentioned in Chap. V. which treats of Iſchia; where ſpeaking of the fuſion obtained in the furnace of ſome feltſpars, though detached, of ſome of the lavas of that iſland, I obſerved that it is not always true that the feltſpars are more difficult to fuſe than ſhoerls, as is generally imagined. I then alluded to what is here detailed, though this is not the only place where that truth will be proved.

I ſhall make another remark or two on theſe ſhoerls. They do not belong, excluſively, to this lava of Monte Roſſo, but are found in many others of Mount Etna.

I do not know that any attempt has been hitherto made to analyſe them chemically. I therefore undertook to aſcertain their component principles by the proceſs with aſbeſtine earth invented by Bergman. From 100 docimaſtic pounds of theſe ſhoerls I obtained the following reſult:

Silex

	Pounds.
Silex - -	34,5
Lime - -	18,7
Iron - -	7,6
Alum - -	12,4
Magneſia -	11,
Sum	84,2 *

Monte Roſſo (the Red Mountain), as we have already ſaid, has received this name from ſome parts of it being tinged with that colour, though there are others which are white, and others yellow. All theſe parts of it are found to be more or leſs decompoſed, and, in general, they are only ſcoriæ. It ſeems indubitable that theſe colours are produced by iron, changed or modified by acids.

Some of theſe ſcoriæ, which have not been

* It muſt be remarked, that beſides the almoſt irreparable loſs in manipulation, and that of the water pre-exiſting in the ſhoerls, the lime is here deprived of the acid with which it was before combined.

affected

affected by the action of the acids, exhibit a remarkable phenomenon. They are covered with a thin coat of pellucid glaſs, and ſeem as if a ſheet of water had flowed over them and been ſuddenly frozen. This appearance, which in the neighbourhood of any other volcano would not merit a moment's regard, is remarkable at Etna, becauſe we there meet with no vitrifications; M. Dolomieu, whoſe induſtry and accuracy are ſo great in all his reſearches, having found only one piece, and that of uncertain origin.

This vitreous integument has very probably been occaſioned by a more energetic action of the fire.

After I had ſtaid ſome time at Monte Roſſo, equally to my inſtruction and amuſement; and had viewed with admiration the trunk and branches of that extenſive river of lava, which iſſuing from the root of the mountain, and inundating an immenſe tract of country, had ruſhed into the ſea; I took my way towards the monaſtery of St. Niccolo dell'

dell' Arena, a pleaſing reſting-place for travellers who viſit Etna, where I arrived about noon on the 3d of September. This very ancient edifice, founded on the lava, was the habitation of a number of Benedictine monks, who about two hundred years ago, in conſequence of the devaſtation occaſioned by the lava, were obliged to abandon it, and retire to Catania. The injuries it has at different times ſuffered are recorded in various inſcriptions ſtill remaining, which commemorate ruinous earthquakes, torrents of lava, and ſhowers of ſand and aſhes, by which it has been damaged and almoſt deſtroyed; with the dates of the different repairs. The environs of this place would ſtill be entirely covered with the black ſand thrown up by Monte Roſſo in 1669, were it not that this ſand becomes more eaſily changed into vegetable earth than the lava; and, for many years, has been planted with more than one extenſive vineyard. After taking a ſlight refreſhment in this hoſpitable place, I continued my journey towards the ſummit of Etna, proceeding over ancient lavas,

which were ſtill every where unproductive of any kind of vegetable.

About three miles above San Niccolo dell' Arena, the lower region of Etna ends, and the middle begins, which extends for ten miles, or nearly that diſtance, in a direct line, up the mountain. It is, with great propriety, called *ſelvoſa*, or the woody region; ſince it abounds with aged oaks, beeches, firs, and pines. The ſoil of this region is a vegetable earth, generated by the decompoſition of the lavas, and ſimilar to that in the lower region; which lavas may not only every where be found on digging a little depth into the ground, but diſplay themſelves uncovered in many places, as we have already remarked of the lavas of the other region. The middle region is celebrated for its luxuriant vegetation and its lofty trees; but it appeared to me ſcarcely to deſerve this celebrity. The trees (at leaſt in the places where I noticed them), and eſpecially the oaks, which form the greateſt part of this woody zone, are low, and as I may ſay ſtinted in their growth;

and

and would loſe much when compared with thoſe of other countries. The beeches, which grow only on the upper extremity of the zone, would appear mere pigmies, if placed beſide thoſe which rear their lofty heads on the Apennines and the Alps. This, I am of opinion, is to be attributed to the little depth of the earth proper for vegetation. The woods and verdure of theſe two regions, the inferior and the middle, are recorded by the greater part of the writers of antiquity; ſo that the commencement of this vegetation appears to be loſt in the obſcurity of time. How much more ancient, then, muſt have been the date of the flowing of thoſe lavas to the ſlow decompoſition of which the vegetation owes its origin!

Before the day cloſed, I reached the celebrated Grotta delle Capre, but it only afforded us a wretched couch of leaves and ſtraw. It is, however, the only place where the traveller can reſt who wiſhes early in the morning to reach the top of Etna, which

is eight miles diſtant. It is one of thoſe caverns which we frequently meet with in the middle of the lavas of that immenſe mountain; and a little higher begins the laſt and ſublime region. Here I ſtopped to paſs the night; but, before I endeavoured to compoſe myſelf to ſleep, I found it very agreeable to warm myſelf by a fire made with ſome branches cut from the neighbouring trees; as, at this height, Reaumur's thermometer ſtood at 8½ degrees above the freezing point (51° of Fahrenheit); while in the morning of the ſame day, at Catania, it had been at 23° (72 of Fahrenheit). Caſting my eye around the grotto, I perceived the names of ſeveral travellers; ſome of them names of eminence, with the dates when they had been here, cut on the trunks of ſeveral of the oaks; but I muſt confeſs that I felt ſome little indignation on remarking that among all theſe there was not one Italian name.

I ſhall conclude this chapter with ſome remarks relative to an object that has not,

to

to my knowledge, been attended to by any other traveller. We have been told that the grotto is called La Grotta delle Capre (the grotto of the goats) becauſe goats are uſed to be ſhut in it, in rainy weather; that it is hollowed in the lava in the ſhape of a furnace; that it is ſurrounded with ancient and venerable oaks; that leaves, there, compoſe the beds of travellers; but no one has yet deſcribed the qualities of the lava of which it is formed. Without pretending perfectly to ſupply this omiſſion, I ſhall ſay that the lava here is of a horn-ſtone baſe; that it is of an earthy texture; and that, though it abounds with pores and vacuities, it has conſiderable hardneſs. It contains ſome ſhoerls, and likewiſe two kinds of ſelt-ſpars; ſome of a flat figure, which are extremely brilliant in the fractures; the others of an irregular ſhape, with little luſtre, and which manifeſt a degree of calcination, though without any indication of fuſion. A few other thin ſmall ſtones are interſperſed in them, which from their hardneſs and green colour I incline to think are chryſolites;

lites; as it is known that theſe noble ſtones are found in many of the lavas of Etna.

This lava in the furnace is transformed into an enamel full of bubbles; and as it then changes to a blacker colour, the white feltſpars become more conſpicuous. The magnetic needle is acted upon by it at the diſtance of a line and a half. The other lavas of the vicinity do not differ from that of the Grotta delle Capre, or rather they are a continuation of the ſame, even where they are covered by a ſtratum of earth and a multitude of trees. It is therefore evident, that this grotto has been formed from time immemorial; and that it is not the work of the rain-water, but has been produced by the action of the claſtic gaſes of the lavas when they were fluid, which have generated in them this hollow place, as they have, elſewhere, many others, of which we may have occaſion hereafter to treat.

CHAP.

CHAP. VIII.

CONTINUATION OF THE JOURNEY TO ETNA.

Upper region of Etna—Deſtitute of vegetables—Its lavas—View of the riſing ſun from thoſe heights—Lavas which iſſued from the principal crater of Etna in the months of July and October 1787—*Difficulty of croſſing thoſe lavas to arrive at the ſummit of Etna—After burning eleven months and more, ſome places not yet extinguiſhed—Other difficulties—Arrival at the top of Etna—Clear view of the great crater, circumference of the great crater, with other particulars—Etna a bifurcated mountain—Another ſmaller crater—Obſtacles uſually met with in a journey to Mount Etna—Compariſon of what the author obſerved within the crater of Mount Etna, with the obſervations before made by M. Riedeſel, Sir William Hamilton, Brydone, and*

Borch—Phyſical cauſes of the changes in volcanic craters—Ancient accounts of theſe changes—Large maſſes have ſometimes fallen from the top of Etna into the crater—No ſenſible diminution of the height of this mountain in the times of which we have any account—Various phenomena obſervable in the ſmoke which at different times has exhaled from the Etnean furnace—No inconvenience experienced by the author from the thinneſs of the air on the top of Etna—The effect of this different, on different individuals—Extenſive and admirable proſpect from the ſummit of Etna.

THREE hours before day, I, with my companions, left the Grotta delle Capre, which had afforded us a welcome aſylum, though our bed was not of the ſofteſt, as it conſiſted only of a few oak leaves ſcattered over the floor of lava. I continued my journey towards the ſummit of Etna; and the clearneſs of the ſky induced me to hope that it would continue the ſame during the approaching day, that I might enjoy the extenſive

ſenſive and ſublime proſpect from the top of this lofty mountain, which is uſually involved in clouds. I ſoon left the middle region, and entered the upper one, which is entirely deſtitute of vegetation, except a few buſhes very thinly ſcattered. The light of ſeveral torches which were carried before us enabled me to obſerve the nature of the ground over which we paſſed, and to aſcertain, from ſuch experiments as I was able to make, that our road lay over lavas either perfectly the ſame with, or analogous to, thoſe in which the Grotta delle Capre is hollowed.

We had arrived at within about four miles of the borders of the great crater, when the dawn of day began to diſperſe the darkneſs of night. Faint gleams of a whitiſh light were ſucceeded by the ruddy hues of aurora; and ſoon after the ſun roſe above the horizon, turbid at firſt and dimmed by miſts, but his rays inſenſibly became more clear and reſplendent. Theſe gradations of the riſing day are no where to be viewed with ſuch preciſion and delight, as from the lofty height

height we had reached, which was not far from the moſt elevated point of Etna. Here, likewiſe, I began to perceive the effects of the eruption of Etna which took place in July 1787, and which has been ſo accurately deſcribed by the Chevalier Gioeni *. Theſe were viſible in a coating of black ſcoriæ, at firſt thin, but which became gradually thicker as I approached the ſummit of the mountain, till it compoſed a ſtratum of ſeveral palms in thickneſs. Over theſe ſcoriæ I was obliged to proceed, not without conſiderable difficulty and fatigue, as my leg at every ſtep ſank deep into it. The figure of theſe ſcoriæ, the ſmalleſt of which are about a line or ſomewhat leſs in diameter, is very irregular. Externally they have the appearance of ſcoriæ of iron; and, when broken, are found full of ſmall cavities, which are almoſt all ſpherical, or nearly of that figure. They are, therefore, light and friable; two qualities which are almoſt always inſeparable from

* His account of this eruption was printed at Catania in 1787. There is likewiſe a French tranſlation at the end of the *Catalogue Raiſonné* of M. Dolomieu.

ſcoriæ. This great number of cavities is an evident proof of the quantity and vigorous action of the elaſtic fluids, which in this eruption, impriſoned in the liquid matter within the crater, dilated it on every ſide, ſeeking to extricate themſelves; and forced it, in ſcoriaceous particles, to various heights and diſtances, according to the reſpective weights of thoſe particles. The moſt attentive eye cannot diſcover in them the ſmalleſt ſhoerl; either becauſe theſe ſtones have been perfectly fuſed, and with the lava paſſed into one homogeneous conſiſtence; or becauſe they never exiſted in it. Some linear feltſpars are however found, which by their ſplendour, ſemi-tranſparency, and ſolidity, ſhew that they have ſuffered no injury from the fire. When theſe ſcoriæ are pulverized, they become extremely black; but retain the dryneſs and ſcabrous contexture which they had when entire. They abound in iron, and in conſequence the duſt produced by pulverizing them copiouſly adheres to the point of a magnetized knife; and a ſmall piece of theſe ſcoriæ will put the

the magnetic needle in motion at the diſtance of two lines.

In the midſt of this immenſe quantity of ſcoriæ, I, in ſeveral places, met with ſome ſubſtances of a ſpherical figure, which, like the lava, were at firſt ſmall, but increaſed in ſize as I approached the ſummit of the mountain. Theſe were originally particles of lava ejected from the crater in the eruption before mentioned, which aſſumed a ſpherical figure when they were congealed by the coldneſs of the air. On examining them, I found them in their qualities perfectly to reſemble the ſcoriæ, and to poſſeſs the ſame magnetiſm.

Only two miles and a half remained of our journey, when the great laboratory of nature, incloſed within the abyſſes of Etna, began its aſtoniſhing operations. Two white columns of ſmoke aroſe from its ſummit; one, which was the ſmalleſt, towards the north-eaſt ſide of the mountain; and the other, towards the north-weſt. A light wind blowing

blowing from the eaſt, they both made a curve towards the weſt, gradually dilating, until they diſappeared in the wide expanſe of air. Several ſtreams of ſmoke, which aroſe lower down, towards the weſt, followed the two columns. Theſe appearances could not but tend to inſpire me with new ardour to proſecute my journey, that I might diſcover and admire the ſecrets of this ſtupendous volcano. The ſun, likewiſe, ſhining in all his ſplendour, ſeemed to promiſe that this day ſhould crown my wiſhes. But experience taught me that the two miles and a half I had yet to go preſented many more obſtacles than I could have imagined, and that nothing but the reſolution I had formed to complete my deſign at every hazard could have enabled me to ſurmount them.

Having proceeded about a hundred paces further, I met with a torrent of lava, which I was obliged to croſs, to arrive at the ſmoking ſummit. My guides informed me that this lava had iſſued from the mountain in October 1787; and as the account of the Chevalier

Chevalier Gioeni, which I have above cited, only mentions the eruption of the month of July of the ſame year, I ſhall here give a brief deſcription of it; as it does not ſeem hitherto to have been deſcribed.

This very recent lava extends three miles in length; its breadth is various, in ſome places being about a quarter of a mile, in others one third, and in others ſtill more. Its height, or rather depth, is different in different parts; the greateſt being, as far as I was able to obſerve, about eighteen feet, and the leaſt ſix. Its courſe is down the weſt ſide of the mountain; and, like the other lava which flowed in the July of 1787, it iſſued immediately from the great crater of Etna. The whole number of the eruptions of this mountain of which we have any record, before and after the Chriſtian era, is thirty-one; and ten only, as we are informed by Gioeni, including that of which he has given an account, have iſſued immediately from the higheſt crater. That which I obſerved may be the eleventh, unleſs it ſhould rather be conſidered

conſidered as the ſame with that deſcribed by the Sicilian naturaliſt; ſince the interval between Auguſt and October is a very ſhort intermiſſion of reſt for a volcano. The cauſe of the rarity of the eruptions which iſſue immediately from the crater, compared with thoſe which diſgorge from the ſides, ſeems eaſily to be aſſigned. The centre of this volcano is probably at a great depth, and perhaps on a level with the ſea. It is, therefore, much more eaſy for the matter liquefied by the fire, put in effervescence by the elaſtic fluids, and impelled on every ſide from the centre to the circumference, to force its way through one of the ſides of the mountain where it finds leaſt reſiſtance, and there form a current, than to be thrown up, notwithſtanding the reſiſtance of gravity, from the bottom to ſo great a height as the higheſt crater of Etna. It is evident, therefore, that the effervescence in the eruptions of the months of July and October 1787 was extremely violent. The torrent of the month of October is every where covered with ſcoriæ, which reſemble thoſe ejected in the month of July in their black colour,

lour, but differ from them in the great adheſion they have to the lava, in their exterior vitreous appearance, their greater weight, and their hardneſs, which is ſo great that they give ſparks with ſteel almoſt as plentifully as flints. Theſe differences, however, are to be attributed only to accidental combinations of the ſame ſubſtance; the conſtituent principles of the ſcoriæ of this lava not being different from thoſe of the detached ſcoriæ mentioned above. Both, likewiſe, contain the ſame feltſpar lamellæ.

This new current was, however, extremely difficult, and even dangerous, in the paſſage. In ſome places the ſcoriæ projected in prominent angles and points, and in others ſunk in hollows, or ſteep declivities; in ſome, from their fragility and ſmoothneſs, they reſembled thin plates of ice, and in others they preſented vertical and ſharp projections. In addition to theſe difficulties, my guides informed me I ſhould have to paſs three places where the lava was ſtill red-hot, though it was now eleven months

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ſince it had ceaſed to flow. Theſe obſtacles, however, could not overcome my reſolution to ſurmount them, and I then experienced, as I have frequently done at other times, how much may be effected, in difficulties and dangers like theſe, by mere phyſical courage, by the aſſiſtance of which we may proceed along the edge of a precipice in ſafety; while the adventurer who ſuffers himſelf to be ſurpriſed by a panic fear will be induced cowardly to deſiſt from the enterpriſe he might have completed. In ſeveral places, it is true, the ſcoriæ broke under my feet; and in others I ſlipped, and had nearly fallen into cavities from which I ſhould have been with difficulty extricated. One of the three places pointed out by the guides had, likewiſe, from its extreme heat, proved highly diſagreeable; yet, at length, I ſurmounted all theſe obſtacles and reached the oppoſite ſide, not without making ſeveral curſory obſervations on the places whence thoſe heats originated. Two large clefts, or apertures, a different places appeared in the lava, which there, notwithſtanding the

clearneſs of the day, had an obſcūrē redneſs: and on applying the end of the ſtaff which I uſed as a ſupport in this difficult journey, to one of theſe, it preſently ſmoked, and, immediately after, took fire. It was, therefore, indubitable that this heap of ejected lava ſtill contained within it the active remains of fire, which were more manifeſt there, than in other places, becauſe thoſe matters were there collected in greater quantities.

I had yet to encounter other obſtacles. I had to paſs that tract which may properly be called the cone of Etna, and which, in a right line, is about a mile, or ſomewhat more, in length. This was extremely ſteep, and not leſs rugged, from the accumulated ſcoriæ which had been heaped upon it in the laſt eruption, the pieces of which were neither connected together, nor attached to the ground; ſo that, frequently, when I ſtepped upon one of them, before I could advance my other foot, it gave way, and, forcing other pieces before it down the ſteep declivity,

clivity, carried me with it, compelling me to make many ſteps backwards inſtead of one forwards. To add to this inconvenience, the larger pieces of ſcoriæ above that on which I had ſtepped, being deprived of the ſupport of thoſe contiguous to them, came rolling down upon me, not without danger of violently bruiſing my feet, or breaking my legs. After ſeveral ineffectual attempts to proceed, I found the only method to avoid this inconvenience, and continue my journey, was to ſtep only on thoſe larger pieces of ſcoriæ which, on account of their weight, remained firm: but the length of the way was thus more than doubled, by the circuitous windings it was neceſſary to make to find ſuch pieces of ſcoriæ as from their large ſize were capable of affording a ſtable ſupport. I employed three hours in paſſing, or rather dragging myſelf, to the top of the mountain, partly from being unable to proceed in a right line, and partly from the ſteepneſs of the declivity, which obliged me to climb with my hands and feet, ſweating and breathleſs, and under the neceſſity of ſtopping at intervals to reſt,

and recover my ſtrength. How much did I then envy the good fortune of thoſe who had viſited Etna before the eruption of 1787, when, as my guides aſſured me, the journey was far leſs difficult and laborious!

I was not more than a hundred and fifty paces diſtant from the vertex of the cone, and already beheld cloſe to me, in all their majeſty, the two columns of ſmoke. Anxious to reach the borders of the ſtupendous gulf, I ſummoned the little ſtrength I had remaining, to make a laſt effort, when an unforeſeen obſtacle, for a moment, cruelly retarded the completion of my ardent wiſhes. The volcanic craters, which are ſtill burning more or leſs, are uſually ſurrounded with hot ſulphureous acid ſteams, which iſſue from their ſides, and riſe in the air. From theſe the ſummit of Etna is not exempt; but the largeſt of them roſe to the weſt, and I was on the ſouth-eaſt ſide. Here, likewiſe, four or five ſtreams of ſmoke aroſe, from a part ſomewhat lower; and through theſe it was neceſſary to paſs; ſince

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on one ſide was a dreadful precipice, and on the other ſo ſteep a declivity that I and my companion, from weakneſs and fatigue, were unable to aſcend it; and it was with the utmoſt difficulty that our two guides made their way up it, notwithſtanding they were ſo much accuſtomed to ſuch laborious expeditions. We continued our journey, therefore, through the midſt of the vapours; but though we ran as faſt as the ground and our ſtrength would permit, the ſulphureous ſteams with which they were loaded were extremely offenſive, and prejudicial to reſpiration; and affected me, in particular, ſo much, that for ſome moments I was deprived of ſenſe; and found, by experience, how dangerous an undertaking it is to viſit volcanic regions infeſted by ſuch vapours

Having paſſed this place, and recovered by degrees my former preſence of mind; in leſs than an hour I arrived at the utmoſt ſummit of Etna, and began to diſcover the edges of the crater; when our guides, who had preceded me at ſome diſtance, turned back,

and, haſtening towards me, exclaimed in a kind of tranſport, that I never could have arrived at a more proper time to diſcover and obſerve the internal part of this ſtupendous volcano. The reader will eaſily conceive, without my attempting to deſcribe it, how great a pleaſure I felt at finding my labours and fatigue at length crowned with ſuch complete ſucceſs. This pleaſure was exalted to a kind of rapture, when I had completely reached the ſpot, and perceived that I might, without danger, contemplate this amazing ſpectacle. I ſat down near the edge of the crater, and remained there two hours, to recover my ſtrength after the fatigues I had undergone in my journey. I viewed with aſtoniſhment the configuration of the borders, the internal ſides, the form of the immenſe cavern, its bottom, an aperture which appeared in it, the melted matter which boiled within, and the ſmoke which aſcended from it. The whole of this ſtupendous ſcene was diſtinctly diſplayed before me; and I ſhall now proceed to give ſome deſcription of it, though it will

will only be poſſible to preſent the reader with a very feeble image, as the ſight alone can enable him to form ideas at all adequate to objects ſo grand and aſtoniſhing.

The upper edges of the crater, to judge by the eye, are about a mile and a half in circuit, and form an oval, the longeſt diameter of which extends from eaſt to weſt. As they are in ſeveral places broken, and crumbled away in large fragments, they appear as it were indented, and theſe indentations are a kind of enormous ſteps, formed of projecting lavas and ſcoriæ. The internal ſides of the cavern, or crater, are inclined in different angles in different places. To the weſt their declivity is ſlight: they are more ſteep to the north; ſtill more ſo to the eaſt; and to the ſouth-eaſt, on which ſide I was, they are almoſt perpendicular. Notwithſtanding this irregularity, however, they form a kind of funnel; large at the top, and narrow at the bottom; as we uſually obſerve in other craters. The ſides appear irregularly rugged, and abound with

concretions of an orange colour, which, at firſt, I took for ſulphur; but, afterwards, found to be the muriate of ammoniac; having been able to gather ſome pieces of it from the edges of the gulf. The bottom is nearly a horizontal plane, about two-thirds of a mile in circumference. It appears ſtriped with yellow, probably from the above-mentioned ſalt. In this plain, from the place where I ſtood, a circular aperture was viſible, apparently about five poles in diameter, from which iſſued the larger column of ſmoke, which I had ſeen before I arrived at the ſummit of Etna. I ſhall not mention ſeveral ſtreams of ſmoke, which aroſe like thin clouds from the ſame bottom, and different places in the ſides. The principal column, which at its origin might be about twenty feet in diameter, aſcended rapidly in a perpendicular direction, while it was within the crater; but, when it had riſen above the edges, inclined towards the weſt, from the action of a light wind; and, when it had riſen higher, dilated into an extended but thin volume. This ſmoke was white, and, being

being impelled to the ſide oppoſite that on which I was, did not prevent my ſeeing within the aperture; in which, I can affirm, I very diſtinctly perceived a liquid ignited matter, which continually undulated, boiled, and roſe and fell; without ſpreading over the bottom. This certainly was the melted lava which had ariſen to that aperture from the bottom of the Ethean gulf.

The favourable circumſtance of having this aperture immediately under my view induced me to throw into it ſome large ſtones, by rolling them down the ſteep declivity below me. Theſe ſtones, which were only large pieces of lava that I had detached from the edges of the crater, bounding down the ſide, in a few moments fell on the bottom, and thoſe which entered into the aperture, and ſtruck the liquid lava, produced a ſound ſimilar to that they would have occaſioned had they fallen into a thick tenacious paſte. Every ſtone I thus threw ſtruck againſt and looſened others in its paſſage, which fell with it, and in like man-

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ner ſtruck and detached others in their way, whence the ſounds produced were conſiderably multiplied. The ſtones which fell on the bottom rebounded, even when they were very large, and returned a ſound different from that I have before deſcribed. The bottom cannot, therefore, be conſidered as only a thin cruſt; ſince, were it not thick and ſolid, it muſt have been broken by ſtones ſo heavy falling from ſo great a height.

This deſcription will, perhaps, be better underſtood by an inſpection of Plate II, which exhibits the ſummit of Mount Etna ſurrounded with large pieces and maſſes of lava. A A A repreſents one edge of the lava of 1787, which iſſued from the upper crater. B B the circumference of the crater, with its cleft C C, through which the internal part is diſcernible. D the flat bottom of the crater. E the aperture in the bottom, from which the larger column of ſmoke F F aroſe; which aperture, though it was on one ſide of the bottom, is, for the greater perſpicuity, repreſented in the middle.

G G that part of the edge of the crater from which its internal part is moſt diſtinctly viſible; and where the deſign of it might moſt conveniently be taken. H H the ſmaller column of ſmoke to the north-eaſt.

To ſatisfy one emotion of curioſity, is frequently to excite another. I had, at firſt, approached this volcano with a kind of ſuperſtitious awe. The hiſtories of every age, the relations of travellers, the univerſal voice of Europe, had all contributed to inſpire thoſe who ſhould adventure to viſit it with dread: but as at this time it ſeemed to have laid aſide its terrors, and was in a ſtate of perfect calmneſs and tranquillity, I was encouraged to become more familiar, and to endeavour to pry into more of its ſecrets. I have already obſerved that the ſide of the crater to the weſt is of a more gentle declivity than the others; and I, therefore, conceived that this might ſerve me as a ladder to deſcend to the bottom; where I might have added to the obſervations I had already made, other novel and important facts. But the perſons whom I had brought

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with me as guides would not conſent that I ſhould expoſe myſelf to ſuch danger. They could not, however, prevent me frommaking, at my eaſe, the obſervations I have here publiſhed, and walking leiſurely about the ſummit of the mountain, notwithſtanding the dangerous conſequences with which they threatened me; telling me that, ſhould the wind change, the column of ſmoke muſt be turned towards us, and might deprive us of life by its peſtilential fumes; that, beſides, we were not certain that the lava at the bottom, which now appeared ſo calm and ſtill, would long remain in the ſame ſtate; but that it was poſſible, from circumſtances difficult to foreſee, that it might be thrown up on a ſudden, and puniſh our imprudent curioſity by burying us beneath the fiery ruin; in ſupport of which ſuggeſtion they produced ſeveral inſtances of ſudden and moſt unexpected eruptions.

We have ſeen above, that there were two columns of ſmoke ariſing from Etna. It is to be remarked that, beſides that point of

of Mount Etna on which I ſtood, there is another to the north, a quarter of a mile higher, and which renders the ſummit of Etna properly bifurcated. Within the firſt prominence is ſunk the crater I have deſcribed; and on the ſide of the other is the ſecond, from which aſcends a leſſer column of ſmoke. The ſecond crater is ſmaller by about the one half, than that I have already deſcribed; and the one is ſeparated from the other only by a partition of ſcoriæ and accumulated lava, which lies in the direction of from eaſt to weſt. I made my obſervations on this ſecond crater from a ſmall diſtance; but it was impoſſible to advance to it, on account of the numerous and thick ſtreams of ſmoke by which it was ſurrounded. This, however, was no great diſappointment, after having ſeen and examined the principal crater, which is that whence ſeveral currents of lava had iſſued in 1787. I ought, certainly, to conſider myſelf as extremely fortunate, in being able to gratify my curioſity with ſo near and diſtinct a view of the objects I have deſcribed; as the guides aſſured me, that,

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among all the times when they had conducted ſtrangers to the ſummit of Etna, this was the only one in which they had a clear and undiſturbed view of the internal parts of that immenſe gulf. After my return to Catania, the Chevalier Gioeni likewiſe declared to me that, in all his different excurſions to that mountain, he had never had a good fortune ſimilar to mine; and that, a month before my arrival, he had made a journey to Etna, with the Chevalier Dolomieu, furniſhed with the neceſſary inſtruments to aſcertain accurately the height of the mountain; but when they had arrived at the foot of the cone, where they had propoſed to begin their operations, they were obliged to return back from the obſtacles they met with, which, to ſay the truth, are commonly neither few nor ſmall.

Etna riſes to a prodigious height above the level of the ſea, and its ſummit is uſually covered with ſnows and ice, and obſcured with clouds, except when the latter are low and range along the ſides. The winds,

winds, likewiſe, frequently blow with ſuch violence that perſons can ſcarcely keep their feet, not to mention the acute cold which benumbs the limbs. But the moſt formidable impediments to the progreſs of the adventurers who attempt this perilous journey, are the ſtreams of ſulphureous vapour which riſe on the ſides, and the thick clouds of ſulphureous ſmoke which burſt forth from the mouth of the volcano, even when not in a ſtate of agitation. It ſeems as if Nature had placed theſe noxious fumes as a guard to Etna, and other fiery mountains, to prevent the approach of curioſity, and ſecure her myſterious and wondrous labours from diſcovery. I ſhould, however, juſtly incur the reproach of being ungrateful, were I not to acknowledge the generous partiality ſhe appeared to manifeſt towards me. At the time I made my viſit, the ſky was clear, the mountain free from ſnows, the temperature of the atmoſphere not incommodious, the thermometer ſtanding at ſeven degrees above the freezing point (48° of Fahrenheit), and the wind favouring my de-

ſign, by driving the ſmoke of the crater from me, which otherwiſe would alone have been ſufficient to have fruſtrated all my attempts. The ſtreams of ſmoke I met with in my way were, indeed, ſomewhat troubleſome, but they might have been much more ſo; though, had our guides conducted us by another road, as, on my return to Catania, I found they might have done, we ſhould have eſcaped this inconvenience.

It here will not be improper to compare theſe obſervations on the crater of Etna with thoſe of Baron Riedeſel, Sir William Hamilton, Mr. Brydone, and Count Borch; as ſuch a compariſon will ſhew the great changes which have taken place in this volcano, within the ſpace of twenty years; that is, from the time when it was viſited by Baron Riedeſel, in 1767, to that of my journey, in 1788. At the time when that traveller made his obſervations, the crater was enlarged towards the eaſt, with an aperture which now no longer exiſts. He has not given the meaſure of its circuit, nor has he

he mentioned the interior aſpect of the crater; probably becauſe he had not ſeen it, having been, as I imagine, prevented by the quantity of ſmoke which, he tells us, continually aſcended from it.

It is worthy of notice, however, that at that time there was not at the bottom of the crater the hard flat ſurface I have deſcribed; ſince the ſtones thrown into it did not return the ſmalleſt ſound. Within the gulf itſelf, was heard a noiſe ſimilar to that of the waves of the ſea when agitated by a tempeſt, which noiſe, probably, proceeded from the lava within the bowels of the mountain, liquefied and in motion. We may hence conceive how eaſily a volcano may begin to rage on a ſudden, though, before, apparently in a ſtate of complete tranquillity; for if we ſuppoſe a ſuperabundant quantity of elaſtic ſubſtances to have been ſuddenly developed in the liquid lava of Etna, either at the time when Baron Riedeſel viſited the crater, or when I obſerved it in a ſtate of ſlight commotion

within the gulf, it muſt immediately have ſwelled in every part, beating violently againſt the ſides of the caverns in which it was impriſoned, thundered among the deep cavities, and, burſting forth through the ſides, have poured out a river of fire; or, ſhould its violence have been there reſiſted, it would have ruſhed up within the crater, until it overflowed its brink, and deluged the ſides of the mountains with its torrents.

Sir William Hamilton, on the 26th of October 1769, arrived at the ſummit of Etna, with great difficulty, on account of the ſnows he met with in his way, the ſeverity of the atmoſphere, the ſulphureous vapours, and the violence of the wind. He was unable to view diſtinctly the lower parts of the crater, being prevented by the great quantity of ſmoke which iſſued from it; though, when this ſmoke was ſometimes driven away by the wind, he could diſcover that the crater was ſhaped like a funnel, diminiſhing until it ended in a point;

point; and that this funnel was incruſted over with ſalt and ſulphur. The crater was two miles and a half in circumference.

From the time, therefore, of the journey of Baron Riedeſel to that of Sir William Hamilton, the crater muſt have undergone great changes in its ſtructure; ſince, if the ſtones that were thrown into it gave no indications to the ear that they ſtruck againſt any ſolid body, it is manifeſt that there muſt then have been an abyſs as well as a funnel; and as the funnel terminated in a point, when it was obſerved by Sir William Hamilton, it is evident that the flat bottom I have deſcribed, and which was about two-thirds of a mile in circuit, did not then exiſt.

The internal ſides of the crater, Sir William tells us, were covered with a cruſt of ſalt and ſulphur: but he does not ſpecify the nature of the former; and though the preſence of the latter is not improbable, he might have been led into a miſtake by the

yellow colour, and have taken the muriate of ammoniac (ſal ammoniac) for ſulphur, as I did before I had examined it. Sir William has not told us that he made any examination at all; and it is probable that he judged only from the appearance it preſented to his eye.

He obſerves, laſtly, that the crater was two miles and a half in circumference; an eſtimate which may be made to agree with mine by neglecting the partition which ſeparates the greater crater from the leſs, and conſidering them both as one. The ſum of the two circumferences, according to the eſtimate I have given, would not then greatly differ from the meaſure of Sir William Hamilton. Nothing, likewiſe, can be more probable, than that among the various changes that have happened to Etna, this partition, by which the great crater is divided into two parts, has been produced.

Omitting the obſervations of Mr. Bry-

done, that " the tremendous gulf of Etna, " ſo celebrated in all ages, has been looked " upon as the terror both of this and " another life ; that it inſpires ſuch awe " and horror, that it is not ſurpriſing " that it has been conſidered as the place " of the damned ;" and other ſimilar philoſophical reflections which he has employed; and confining ourſelves to what he actually ſaw on the 29th of May 1770, we learn from him that " the crater was " then a circle of about three miles and a " half in circumference; that it went ſhelving down on each ſide, and formed a " regular hollow, like a vaſt amphitheatre; " and that a great mouth opened near the " centre*.

From the time of the journey of Sir William Hamilton, therefore, to that of the viſit of Brydone, that is to ſay, within the ſhort ſpace of a year, various changes had happened to this volcano, by the enlarge-

* Brydone's Tour through Sicily and Malta, vol i. p. 195, 196.

ment of its crater, and a ſpacious aperture formed in its bottom.

Count Borch appears to have wiſhed to exceed the three other travellers in brevity, relative to this ſubject; ſince he only tells us that he arrived at the mountain on the 16th of December 1776, and that the crater of Etna is formed like a funnel. He adds, however, what is worthy of notice, that the ſummit of Etna is bifurcated, as I obſerved it to be: a circumſtance not noticed by others, Sir William Hamilton even affirming that the ſummit of the mountain is ſingle; whence we may conclude that one of theſe ſummits has been produced ſince the time of the journey of Brydone, in 1770.

On comparing the above-cited obſervations, made within the ſpace of twenty-one years, we may perceive how many changes have taken place in Etna, during that interval; and, as, within that time, the mountain has ſuffered only two violent convulſions,

ſions, in the eruptions of 1781 and 1787, it is evident that, even in the ſtate of apparent inaction, it ſtill internally exerts its force.

To theſe obſervations it may, likewiſe, not be without utility to add thoſe of M. D'Orville. He aſcended Etna, in 1727, and remarked two craters; one larger than the other. The latter he only mentions, but the former he deſcribes at ſome length. Its circumference was, perhaps, ſomewhat more than four miles. From it iſſued clouds of ſmoke and reddiſh flames. Theſe, however, did not prevent his approaching to the edge of the gulf; though, to prevent the danger of falling into it, he and his companions faſtened themſelves to a rope held by three men. On looking into the crater, they were unable to diſcern the bottom, on account of the flames and ſmoke: they only obſerved that a conical hill, formed of lava, roſe in the middle of the crater, the top of which they eſtimated to be ſixty feet below them; and they were able to ſee, perhaps,

about ſixty feet lower; where they conjectured the circuit of this hill might be from ſix hundred to eight hundred feet*.

We have here a remarkable circumſtance relative to Etna, as it appeared in the time of M. D'Orville, and not obſerved by any one of the four travellers above cited—I mean the conical hill within the crater. Every obſervation, therefore, tends to confirm the inconſtancy of the internal configuration and dimenſions of this volcano. It is an extinguiſhed forge, which, in proportion to the violence of the fire, to the nature of the foſſil matters on which it acts, and of the elaſtic fluids which urge and ſet it in motion, produces, deſtroys, and re-produces various forms. The uſual and natural figure of the ſummit of a volcanic mountain is that of an inverted concave cone, within, and one ſolid and erect without; and ſuch a configuration, in countries which are no longer in a ſtate of conflagration, is one of the moſt certain indications of the exiſtence

* Jacobi Philippi D'Orville Sicula,

of

of an ancient volcano. This cone, however, is liable to very great changes; according to the greater or leſs fury of the volcano, and the quantity and quality of the matters ejected. Its internal part, from more than one cauſe, is expoſed to continual violence and change. The prodigious cavities of the mountain make it almoſt appear ſuſpended in the air. It may eaſily, therefore, give way, and fall in; eſpecially on the violent impulſe of new matters which endeavour to force a paſſage through the upper part; in conſequence of which the inverted cone may, according to circumſtances, preſent the appearance of an aperture, or whirlpool, or a gulf. Should the liquid lava paſs through the aperture, and continue there ſome time, its ſuperficies, by the contact of the cold air, loſing its heat gradually, would congeal, and form a cruſt or ſolid plain; and ſhould the fluid lava beneath, afterwards, act forcibly on this cruſt, it might burſt it, or make a paſſage where it found leaſt reſiſtance; in which caſe the melted lava would occupy that aperture. Should then the cruſt, inſtead of aſcending in a ſingle body,

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be forced up in ſmall fragments, theſe, cooled in the air, would fall down, in immenſe quantities, within the crater, and, from the effect of the laws of gravity, muſt accumulate in the figure of a cone. Theſe theoretical conjectures, if they do not perfectly explain, may at leaſt enable us to conceive, the nature of the cauſes which have produced the difference of appearance obſerved at different times in the crater of Etna.

It is much to be regretted that we have no hiſtory of Etna; which, did we poſſeſs it, muſt greatly contribute to elucidate the theory of volcanos, and the cauſes of the various changes which have taken place, at different times, in the ſummit of this mountain. That ſuch changes have happened, is evident from the few, but valuable, notices concerning Etna, which we find in ancient authors. Of theſe I ſhall briefly ſtate two or three which appear to be of moſt importance.

I ſhall firſt produce the authority of Strabo, though he was not himſelf an ocu-

lar witneſs, but relied on the information of others, who had viſited Etna, and from whom he received the account, " That the " ſummit was a level plain, of about twenty " ſtadia in circumference, ſurrounded by a " brow, or ridge, of the height of a wall; " and that in the middle of the plain aroſe " a ſmoky hill, the ſmoke of which aſcended " in a direct line, to the height of two hun- " dred feet*."

If we conſider this deſcription as accurate, the crater of Etna was at that time ſurrounded by a brow or ridge, which I ſhould explain as the ſides or edges; and, in the lower part, was ſeparated by a mount riſing in the middle †. The ſame geographer re-

* Οι δ'ουν νεωςὶ ἀναβαντες διηγουντο ἡμιν, οτι καταλαβοιεν ἀνω πεδιον ὁμαλον, ὁσον εἰκοσι ςαδιων την περιμετρον, κλειομενον ὀφρυι τεφρωδει, τειχιου το ὑψος ἐχοντι, οραντε το μεσον βουνον τεφρωδη την χροαν, ὑπερ δε του βουνου νεφος ὀρθιον διανεςηκος τι ὑψος ὁσον διακοσιων ποδων εικαζειν δε καπνω.

† This obſervation agrees with that of D'Orville mentioned above. I find, likewiſe, that ſimilar mounts have ſometimes been thrown up within the crater of Veſuvius. De Bottis *Iſtoria di varj incendj del Veſuvio.*

lates

lates that two men, having ventured to descend upon that plain, were obliged immediately to return, from the violence of the heat*.

Solinus tells us that there were two craters from which the vapours issued†.

Cardinal Bembo likewise found two craters on the summit, the one higher than the other, and about as far distant as a stone might be thrown from a sling. The extreme violence of the wind, and the exhaling fumes, prevented him from approaching the upper crater. The lower he found to be formed like an immense pit, and surrounded with a plain of no great extent, which was so hot that he could not bear his hand on it. From its mouth, as from a chimney, continually issued a column of smoke.

* Δυο δε τολμησαντας προσελθειν εις το πεδιον· ἐπειδε θερμοτερας ἐβαινον της αμμου και βαθυτερας, αναστρεψαι, μυδον εχοντας περιτοτερον φραζειν των φαινομενων τοις πορρωτον αφορωσι.

† In Etnæ vertice hiatus duo sunt, crateres nominati, per quos eructatus erumpit vapor. Cap. xi.

Of

Of the other crater, which he could not obſerve himſelf, hereceived a deſcription, at Catania, from a monk, who, he aſſures us, was a man deſerving credit, and well acquainted with ſuch ſubjects. He informed him that this crater was ſituated on the higheſt part of the ſummit of Etna; that it was about three miles in circumference; formed like a funnel; and that it had in the middle a ſpacious cavity. He aſſerted that he had made the circuit of it, along a kind of narrow ridge; that, from time to time, it threw out ſtones and burning matters, to a conſiderable height, roaring, and ſhaking the ground; but that, in the intervals when it was undiſturbed, he had obſerved it without danger or difficulty.

In the time of Fazello, however, who viſited Etna after Cardinal Bembo, there were no longer two craters, but only one; the circumference of which, as he informs us, was four miles. It had the uſual form of the funnel, emitted fire and thick ſmoke, but, at intervals, was calm, and might be approached;

approached; at which times a ſubterrancous noiſe was heard, and a ſound like that of the boiling of an immenſe caldron on a vaſt fire. Theſe obſervations were made by him in 1541, and 1554; in both which years the crater appears to have been ſingle.

Theſe few citations appear to me ſufficient to ſhew what changes have taken place in the ſummit of Etna, relative to the number, the form, and the ſize of its craters, according to the different effects of its conflagrations at different times. But there is likewiſe another alteration which ſhould not be paſſed unnoticed, deſcribed by two writers who themſelves obſerved it, Fazello and Borelli; I mean the falling in and abſorption of the extreme ſummit of Etna within its crater. The former of the above-mentioned authors relates that, in his time, there aroſe, in the mouth of the crater, a little hill, iſolated on every ſide, which formed the vertex of the mountain; and

* Fazel. Sic.

which,

which, in a terrible eruption, fell into, and was buried in, the gulf, thus enlarging the crater, and diminiſhing the height of the mountain. This hill itſelf had been produced by a former eruption in 1444*.

In like manner, Borelli informs us that, in the conflagration of 1669. the ſummit of Etna, which roſe, like a tower, to a great height above the part which is level, was ſwallowed up in the deep gulf †.

I have already ſaid, that, when I viſited Etna, its ſummit was divided into two points, or little mountains, one of which roſe a quarter of a mile above the other. I ſhould not be ſurpriſed were I to hear that, in ſome new and fierce eruption, the higheſt of theſe had fallen in, and the two craters become one of much larger dimenſions. We know that the ſummit of Veſuvius has ſometimes fallen down in the ſame manner; nor

* Ubi ſup.

† Ubi ſup. See Plate I.

does

does it appear difficult to aſſign the cauſe. It ſeems to admit of no doubt that the higheſt parts of Etna, and other mountains which vomit fire from their ſummits, have their foundations on the ſides of the crater, which extend to an immenſe depth. In any violent earthquake, therefore, or impetuous ſhock of the lava endeavouring to force a paſſage, it may eaſily be imagined that thoſe foundations muſt be torn up and broken away, and the ſummit of the volcano fall and be loſt in the gulf.

Theſe dilapidations have not, however, from time immemorial, produced any ſenſible diminution of the height of the ſummit of Etna; ſince the loſſes occaſioned by ſome eruptions are repaired by others which follow. This may be inferred from a phenomenon uſually inſeparable from the ſummit of Etna, though, by a rare accident, not obſervable at the time of my journey; I mean the ice and ſnow with which it is covered. Had any conſiderable decreaſe of the height of the mountain taken place, in

conſequence

conſequence of the ſummit repeatedly falling in, in former ages, the ice and ſnow would not, certainly, in a climate ſo mild, have continued to envelop the top of the mountain, as they now do, even during the greateſt heats of ſummer. But this continual reſidence of the ſnow and ice on Etna has been celebrated by all antiquity; for near obſervation was not neceſſary to aſcertain this phenomenon, ſince it is diſtinctly apparent at the diſtance of a hundred miles. "Adſcendit ea regio (ſays Fazello, ſpeaking of the Upper Region of Etna) paſſuum millia fere xii.; quæ per hyemem tota nivibus obſita extremiſque frigoribus riget: per æſtatem quoque nulla ſui parte nec canitie nec gelu caret: quod equidem admiratione dignum eſt; cum vertex incendia prope ſempiterna jugi flammarum eructatione inter nives ipſas pariat, enutriat, ac continuet.' "This region extends nearly twelve miles; "and, even in ſummer, is almoſt perpetually "covered with ſnow, and extremely cold; "which is the more wonderful as the ſum- "mit continually produces, nouriſhes, and

" pours forth flames, amid the ice and ſnow
" with which it is enveloped."

Solinus and Silius Italicus give the ſame deſcription. The former ſays—" Mirum eſt quod in illa ferventis naturæ pervicacia mixtas ignibus (Ætna) nives profert: et licet vaſtis exundet incendiis, aprica canitie perpetuo brumalem detinet faciem *."
" Etna, in a wonderful manner, exhibits
" ſnows mixed with fires; and retains
" every appearance of the ſevereſt winter
" amid her vaſt conflagrations."

Silius Italicus has the following lines:

" Summo cana jugo cohibet (mirabile dictu)
Vicinam flammis glaciem, æternoque rigore
Ardentes horrent ſcopuli; flat vertice celſi
Collis hyems, calidaque nivem tegit atra favilla †."

" Where burning Etna, towering, threats the ſkies,
" 'Mid flames and ice the lofty rocks ariſe;
" The fire amid eternal winter glows,
" And the warm aſhes hide the hoary ſnows."

And ſince I have quoted a poet, I will cite two others; Claudian and Pindar; as it

* Cap. xi. † Lib. xiv.

is ſufficiently evident that poetry here muſt expreſs truth and not fiction.

" Sed quamvis nimio fervens exuberet æſtu,
Scit nivibus ſervare fidem: pariterque favillis
Dureſcit glacies, tanti ſecura vaporis,
Arcano defenſa gelu, fumoque fideli
Lambit contiguas innoxia flamma pruinas *."

" Amid the fires accumulates the ſnow,
" And froſt remains where burning aſhes glow;
" O'er ice eternal ſweep th' inactive flames,
" And winter, ſpite of fire, the region claims."

Thus the Latin poet; but the Greek has given us a picture of Etna much more highly coloured, repreſenting it not only as the eternal abode of ſnows, but as the column of heaven, to expreſs its aſtoniſhing height.

" Κιων δ' ἐραννια
Νιφοεσσ' Αἶνα παντετες
Χιονος ὀξειας τιθηνα †."

" Snowy Etna, nurſe of endleſs froſt,
The mighty prop of heaven."

* Claud. de Rapt. Proſ.

† Pind. Pyth. Od. i.

It is to be remarked that Pindar lived five hundred years before the Chriſtian æra.

I now return from this digreſſion, which, though not, indeed, very ſhort, appears to me perfectly appropriate to the ſubject; and proceed to reſume my narrative. I ſhall firſt ſpeak briefly of a phenomenon relative to the ſmoke which ariſes from the crater of Etna, and which was ſeen differently by Mr. Brydone, Count Borch, and myſelf. Mr. Brydone tells us that "from "many places of the crater iſſue volumes "of ſulphureous ſmoke, which being much "heavier than the circumambient air, in- "ſtead of riſing in it, as ſmoke generally "does, immediately on its getting out of "the crater, rolls down the ſide of the moun- "tain, like a torrent, till coming to that "part of the atmoſphere of the ſame ſpe- "cific gravity with itſelf, it ſhoots off hori- "zontally, and forms a large track in the "air according to the direction of the "wind."

On the contrary, the ſmoke when ſeen by Count Borch, at the intervals when the air was calm, aroſe, perpendicularly, to a great height, and afterwards fell, like white fleeces, on the top of the mountain. I ſhall not preſume to doubt theſe two facts, though I obſerved neither of them. The two columns of ſmoke which I ſaw, though bent ſomewhat from the perpendicular by the wind, aſcended with the uſual promptitude of ordinary ſmoke (a certain proof that it was conſiderably lighter than the ambient air), and, when at a great height, became extremely rareſied and diſperſed. This difference in the appearance of the ſmoke, as obſerved by the two authors before mentioned and myſelf, may ariſe not only from the gravity of the air on Etna being different at different times, but alſo from the diverſity of the ſmoke, which may be ſometimes lighter and ſometimes heavier than the air that ſurrounds it; differing in its nature according to the quality of the ſubſtances from which it is produced. Such a variation in its ſpecific gravity muſt induce us to

conclude that the bodies which burn within the crater are ſpecifically different.

The effects of the air at the ſummit of Etna, as experienced by myſelf and ſome of the travellers I have before cited, were, likewiſe, different. Sir William Hamilton tells us, that the thinneſs of that fluid occaſioned a difficulty of reſpiration; and Count Borch appears to have experienced a ſtill greater inconvenience of that kind, ſince he ſays—"The rarity of the air on this moun-" tain is extremely ſenſible, and almoſt ren-" ders that fluid unfit for reſpiration." On the contrary, Baron Riedeſel felt no ſuch effect, as far, at leaſt, as we can judge from his own words. "I did not perceive, as " ſeveral travellers have aſſerted, that the " air here is ſo thin and rarefied as to pre-" vent, or at leaſt greatly incommode, reſpi-" ration." Mr. Brydone has ſaid nothing on the ſubject, and his ſilence may induce us to conclude that he experienced no difficulty.

I, my

I, my ſervant, and the two guides, ſuffered no inconvenience from the air. The exertions we had made, indeed, in climbing up the craggy ſteep declivities which ſurround the crater, had produced a ſhortneſs of breathing; but when we had reached the ſummit, and recovered from our wearineſs by reſt, we felt no kind of inconvenience, either while ſitting, or when, incited by curioſity, we went round and examined different parts of the edges of the crater. The ſame is affirmed by Borelli: "Æquè bene reſpiratio in cacumine Ætnæ abſolvitur, ac in locis ſubjectis campeſtribus."—"Reſpiration is performed with the ſame "eaſe on the top of Etna, as in the country "below."

Several writers have treated of the difficulty of reſpiration experienced by thoſe who travel over high mountains, and other inconveniencies to which they are expoſed; but none, in my opinion, more judiciouſly than M. Sauſſure, in his Travels among the Alps. The obſervations he has made a-

pear to me to explain the cauſe of theſe different accounts, relative to the effect of the air on the top of Etna. When the height above the level of the ſea was 2450 poles, or nearly ſuch, which he found to be that of Mount Blanc, every individual felt more or leſs inconvenience from the rarefaction of the air, as happened to himſelf and nineteen perſons who accompanied him, when, in Auguſt 1787, he aſcended that mountain. But when the elevation was much leſs, as for example, 1900 poles, ſome of theſe perſons felt no difficulty, among whom was this naturaliſt; though he confeſſes that he began to experience inconvenience as he aſcended higher. We have not indeed any certain obſervations relative to the exact height of Etna, as is ſufficiently proved by the different eſtimates given by different naturaliſts. Signor Dangios, however, aſtronomer at Malta, in the year 1787, meaſured the height of this mountain by a geometrical method, and the public anxiouſly expects the reſults, which will ſatisfactorily ſolve this important problem. In the mean time, from comparing

the

the meaſures hitherto aſſigned, the elevation of Etna above the level of the ſea is probably ſomewhat leſs than 1900 poles. Hence we underſtand why reſpiration, in many perſons, is not incommoded, while the contrary happens to others, according to the different ſtrength and habit of body of different individuals.

After having, for two hours, indulged my eyes with a view of the interior of the crater, that is, in the contemplation of a ſpectacle which, in its kind, and in the preſent age, is without a parallel in the world; I turned them to another ſcene, which is likewiſe unequalled for the multiplicity, the beauty and the variety of the objects it preſents. In fact, there is, perhaps, no elevated region on the whole globe which offers, at one view, ſo ample an extent of ſea and land as the ſummit of Etna. The firſt of the ſublime objects which it preſents is the immenſe maſs of its own coloſſal body. When in the country below it, near Catania, we raiſe our eyes to this ſovereign of the mountains, we

certainly

certainly ſurvey it with admiration, as it riſes majeſtically, and lifts its lofty head above the clouds; and with a kind of geometric glance we eſtimate its height from the baſe to the ſummit: but we only ſee it in profile. Very different is the appearance it preſents, viewed from its towering top, when the whole of its enormous bulk is ſubjected to the eye. The firſt part, and that neareſt the obſerver, is the Upper Region, which, from the quantity of ſnows and ice beneath which it is buried during the greater part of the year, may be called the frigid zone, but which, at that time, was diveſted of this covering, and only exhibited rough and craggy cliffs, here piled on each other, and there ſeparate, and riſing perpendicularly; fearful to view and impoſſible to aſcend. Towards the middle of this zone, an aſſemblage of fugitive clouds, irradiated by the ſun, and all in motion, increaſed the wild variety of the ſcene. Lower down, appeared the Middle Region, which, from the mildneſs of its climate, may merit the name of the temperate zone. Its numerous

woods,

woods, interrupted in various places, ſeem, like a torn garment, to diſcover the nudity of the mountain. Here ariſe a multitude of other mountains, which in any other ſituation would appear of gigantic ſize, but are but pigmies compared to Etna. Theſe have all originated from fiery eruptions. Laſtly, the eye contemplates, with admiration, the Lower Region, which, from its violent heat, may claim the appellation of the torrid zone; the moſt extenſive of the three, adorned with elegant villas and caſtles, verdant hills, and flowery fields, and terminated by the extenſive coaſt, where, to the ſouth, ſtands the beautiful city of Catania, to which the waves of the neighbouring ſea ſerve as a mirror.

But not only do we diſcover, from this aſtoniſhing elevation, the entire maſſy body of Mount Etna; but the whole of the iſland of Sicily, with all its noble cities, lofty hills, extenſive plains, and meandering rivers. In the indiſtinct diſtance we perceive Malta; but have a clear view of the environs of Meſſina,

Meſſina, and the greater part of Calabria; while Lipari, the fuming Vulcano, the blazing Stromboli, and the other Eolian iſles, appear immediately under our feet, and ſeem as if, on ſtooping down, we might touch them with the finger.

Another object no leſs ſuperb and majeſtic, was the far-ſtretching ſurface of the ſubjacent ſea which ſurrounded me, and led my eye to an immenſe diſtance, till it ſeemed gradually to mingle with the heavens.

Seated in the midſt of this theatre of the wonders of Nature, I felt an indeſcribable pleaſure from the multiplicity and beauty of the objects I ſurveyed; and a kind of internal ſatisfaction and exultation of heart. The ſun was advancing to the meridian, unobſcured by the ſmalleſt cloud, and Reaumur's thermometer ſtood at the tenth degree above the freezing point. I was therefore in that temperature which is moſt friendly to man; and the refined air I breathed, as

if it had been entirely vital, communicated a vigour and agility to my limbs, and an activity and life to my ideas, which appeared to be of a celeſtial nature.

Not without regret, I, at length, recollected it was time to return, and relinquiſh this enchanting ſcene; ſince I had determined to paſs the enſuing night at San Niccolo dell' Arena, to avoid the hard bed and inconveniencies of the Grotto delle Capre. I had reſolved, likewiſe, to return to Catania by another way, in order to examine objects which might render my journey of greater utility. The road I took, the objects which preſented themſelves, and the obſervations I made on them, I ſhall relate in the following chapter.

CHAP.

CHAP. IX.

RETURN FROM MOUNT ETNA TO CATANIA.

Manner in which the Author deſcended with eaſe and ſecurity from the ſummit of Etna—Materials of which the Torre del Filoſofo is compoſed—Confirmation that the lava which flowed in October 1787, is ſtill internally penetrated by the fire—The obſervation that the ſecondary mountains on the ſides of Etna are of volcanic origin, not novel but antient—Probability that Monte Roſſo was the reſult of a partial eruption which had no communication with the crater of Etna—Another eruption from the ſides of Etna which had no connection with that crater—Great want of water experienced by the peaſants who inhabit Etna, from a long dry ſeaſon—Affecting incident ariſing from this circumſtance—A ſcarcity of ſprings common in volcanized countries—

The

The Scogli de' Ciclopi, or Rocks of the Cyclops—Some of them, but not all, of a priſmatic conformation—Zeolites found on theſe rocks—Vitrification of thoſe zeolites in the furnace—Pumices not found on Mount Etna, as has been affirmed by Count Boreh, and others—Animals obſerved by the Author in the Middle and Upper Regions of Etna—Two Muſeums in Catania already known to ſtrangers, and a third lately eſtabliſhed, valuable for its contents—Natural Hiſtory little cultivated at Catania, with reſpect to that part which relates to the Mineral Kingdom; but more relatively to the Animal.

THE aſcent up the ſteep and craggy cone of Etna, though not more than a mile in a direct line, coſt me, as I have already ſaid, three hours of laborious and fatiguing exertion. It ſeems ſcarcely neceſſary to ſay that the deſcent employed me leſs time, but the difference greatly exceeded my expectation. I found that to effect this deſcent no

thing

thing more was required, but to fix my feet firmly on ſome large piece of ſcoria, and balance my body, ſince that piece, from almoſt the ſmalleſt impulſe I could give it, would ſlide ſwiftly down the deſcent, and convey me to a conſiderable diſtance, till ſtopped by the accumulation of the leſſer pieces of ſcoriæ which it drove before it; when I had only to ſelect another large piece, on which I again glided down as before; only taking care, with the ſtaff I held in my hand, to turn aſide the pieces of ſcoriæ which followed me in my deſcent, that they might not ſtrike againſt and wound my legs. In this manner, in a few minutes, I arrived at the bottom of that declivity.

A little below the ſummit of Etna, are the ruins of a very ancient fabric, called La Torre del Filoſofo, the Tower of the Philoſopher; it having been pretended, and believed by many, that it was built by Empedocles, that he might fix his habitation in a place convenient for obſerving the conflagrations of Etna. Others imagine it to have been

been an ancient temple of ſome deity; while others have conjectured that it was a watch-tower, built by the Normans, to obſerve the motions of their enemies, and give notice of them, by ſome ſignal, to the different bodies of troops ſcattered over the iſland. It is very apparent that theſe, and other opinions which I omit for the ſake of brevity, are very inconcluſive with reſpect to the real uſe and deſign of this ruined edifice, which could but little attract the notice of hiſtory. I did not viſit it in my journey to Etna, having been conducted another way by my guides. Nor ſhould I have regretted not having ſeen it, had I not reflected, that the great antiquity of the fabric might juſtly excite a curioſity to examine the materials, and aſcertain whether they were lateritious or volcanic. This induced me, after I had returned to Italy, to write to the Abbate Franceſco Ferrara, at Catania, a perſon well verſed in the ſcience of nature, requeſting him to ſend me, to Pavia, ſome ſpecimens of the materials of which the Torre del Filoſofo was compoſed. He very politely

complied with my requeſt, and I found, on examination, that theſe materials were of the following kind. They conſiſt, firſt, of a cement of lime, which, by length of time, has become carbonate of lime; in which cement were incorporated great numbers of pieces of black cellular ſcoriæ of lava; but ſo changed by the effect of time, that many of them were become externally pulverulent, and internally extremely friable. The ſhoerls they contained had likewiſe loſt, at the ſuperfices of the ſcoriæ, their natural lineaments, and all their luſtre, and were become ſo ſoft that they might every where be cut with the point of a penknife. This cement was, in the ſecond place, united to two kinds of lava, which exhaled an argillaceous odour in their fractures, and had for their baſe the hornſtone. One of theſe was very compact, extremely hard, of a ferruginous colour, a fine grain, with numerous felt-ſpar points ſcattered in it. The other was a grey colour, of rather a fine texture, and contained an incredible quantity of feltſpars; ſo that, when viewed with a lens, by the clear light

light of the ſun, it appeared extremely brilliant. The materials, therefore, of this edifice, whatever was its original deſtination, were, in part, taken from the place, with the addition of a cement of lime, to give the building the neceſſary ſolidity *.

I, afterwards, again croſſed the lava which flowed in October 1787, and, as I returned by a different way, I found myſelf near another part of it, where it ſtill remained extremely hot; which tended to confirm me in my opinion that the internal and central part of this lava ſtill contains a very active and ſtrong fire.

Having reached the middle region, I aſcended ſome of thoſe mountains which I had obſerved from the ſummit of Etna, and which, from their conical figure, and the ca-

* I have read, in the works of ſome travellers, that fragments of brick and marble are found in the Torre del Filoſofo; but the Abbate Ferrara has aſſured me that ſuch fragments no longer exiſt.

vity at their top, clearly ſhew that they are the productions of fire *. I was, in fact, convinced that they bear unequivocal marks of the effects of that deſtructive agent, in an accumulation of lavas, ſcoriæ, and volcanic ſand.

Another

* I had at firſt believed that the obſervation that theſe mountains are truly volcanic was of late date, referring it to Sir William Hamilton, who has deſcribed their conical form, and the crater, or incavation at their ſummit; but I find it to be very old, ſince it is mentioned by Borelli, and, before him, by Fazello. The following are the words of the former: "Extant nedum in ſummitate Ætnæ, ſed etiam in ejus dorſo, campeſtres voragines, quæ habent fere omnes peculiarem monticulam adinſtar verrucæ in animalis cute exporrectæ; ſuntque prædicti colles valde acclives, habentque figuram coni acutanguli plano parallelo baſi diſſecti; et in ſummitate cujuſlibet eorum ſinuoſa cavitas reperitur, a qua olim flammæ, arenæ, et glaræ exierunt."—"Extinct vortices (or craters) are found not only on the ſummit of Etna, but alſo on the ſides. They have almoſt all of them their peculiar hills, projecting like a wart on the ſkin of an animal; which hills are extremely ſteep, and have the figure of a rectangular cone diſſected parallel to its baſe. At the top of each is a ſinuous ca-

vity,

Another enquiry relative to theſe mountains here naturally ſuggeſts itſelf. Is their origin derived from the melted matter contained within the immenſe abyſs of Etna, which, unable to reach the crater, from the exceſſive height, has burſt forth through its ſides, and thus formed theſe mountains? or, as is perhaps more probable, have they been produced by particular conflagrations and eruptions which have no communication with the immenſe furnace within the crater?

" vity, from which formerly iſſued flames, ſand, and " lava."

We know that by *glarea* he means lava; in fact, at Catania, it is ſtill called *ſciara*.

Fazello had before obſerved and deſcribed theſe volcanic hills. His words are: " Plurimos præterea nemo " noſos et editos offendimus colles, quorum cacumina " voragines, licet ſilveſcentes, exhibebant. Eos veterem " eſſe materiam ex viſceribus montis olim proditam, " poſtremi profluvii hiatus, qui ſimilem fere formam, " enataſque recens habet arbores, arguebat."—" We " likewiſe find ſeveral lofty hills, the tops of which, " though overgrown with wood, exhibit the appearance " of craters. The mouth of the laſt eruption, which " is nearly of the ſame form, and already bears trees, " renders it probable that they are compoſed of the

crater? I know that the generality of volcaniſts embrace the former opinion, and reject the latter with contempt; and I find, that, whenever the leſſer mountains are produced on the ſides of the principal volcano, by the means of eruptions, they uſually have recourſe to this hypotheſis for the explication of the cauſe. Thus, ſince the eruptions of lava which have iſſued from the crater of Veſuvius are much more numerous than thoſe of Etna, they endeavour to account for the

" matter anciently ejected from the bowels of the " mountain."

The ſame obſervation is likewiſe repeated by D'Orville, who, in 1727, viſited Etna—" Colles hi non ſo- " lum circum magnum craterem (Ætnæ), verum etiam " inde per circuitum viginti mille paſſuum et ultra in " toto monte diſperſi ſunt. Omnes hos colles aliquan- " do igneam materiam e ſummo vertice ejeciſſe, om- " nia ſuadent; et in multis hujus rei adeo aperta extant " veſtigia, ut nemo dubitare poſſit. Quin ipſe in cul- " mine collis illius, quem *metæ* ſimilem diximus, poſitos " in verticibus nonnullorum crateres depreſſos, et plane " undique lapidum exuſtorum congerie circundatos " animadverti."—" Theſe hills are not only found ad- " joining to the great crater, but are diſperſed in a cir- " cuit of twenty miles and more, and, indeed, through- " out

the difference, by alleging, that, in conſequence of the ſmall height of the former volcano, the lava can more eaſily reach the crater; whereas, in the latter, it is compelled to force a paſſage through the ſide, from being unable to riſe to ſo prodigious an elevation.

I readily admit, that this frequently happens; but inſtances may certainly be cited which afford ſtrong reaſons to believe that the production of the lateral mountain ariſes from partial eruptions, which have no communication with the principal crater. Of this Monte Roſſo is an example. In the

" out the whole mountain. Every appearance proves " that all theſe hills have once ejected a fiery matter " from their ſummits; and in many the traces of this " are ſo evident, that it is impoſſible to entertain a doubt. " The remains of craters are apparent, and they are " frequently ſurrounded with accumulations of burnt " ſtones."

Thus we find the deſcription given by the Engliſh naturaliſt of this leſſer volcanic mountain, had been preceded by that of a Sicilian, an Italian, and a Dutch writer, all eye-witneſſes of what they deſcribed.

morning of the 11th of March 1669, a vaſt cleft opened not far from the place in which, afterwards, Monte Roſſo aroſe, and extended for the ſpace of ten miles, in the direction of the grand crater of Etna, (V. V. V. Plate I.) On the night following, in the place where this mountain now ſtands, another large cleft opened, from which were immediately ejected immenſe clouds of ſmoke, and ſhowers of melted ſtones, preceded by a tremendous noiſe, and violent concuſſions of the earth.

On the night of the 12th, a river of lava poured down; and, the next day, a prodigious quantity of ſand and ſtones was thrown out. Yet, during all theſe ſubterranean thunders, convulſions of the earth, ſtreams of lava, and ſhowers of ſtones, the upper crater of Etna was perfectly undiſturbed, and only, from time to time, emitted ſome light ſmoke which had before iſſued, and is uſual in its greateſt ſtate of tranquillity*. I know not whether I am miſtaken in conſidering this

* Borelli, ubi ſup.

as

as a probable proof that there is no communication between the higheſt mouth of Etna, and the new one which has opened in the ſide ſome miles diſtant from it. I have obſerved likewiſe, with Borelli, that the higheſt crater, having remained ſilent and at reſt until the twenty-fifth day, afterwards began to rage with the ſame ſymptoms of ſmoke, thunders, earthquakes, and ejected ſand and ſtones; and in fine, by the ruin of its ſummit, precipitated and buried in its gulph. It ſeems extremely probable, that this change has been effected by the breaking away of the ſtony maſs which ſeparated the old and new gulphs, in conſequence of which the fire and effervoſcent matters forced their paſſage, and diſcharged themſelves from another opening at the ſummit of the mountain.

We muſt not omit to notice another fact related by the ſame writer, which, though it does not reſpect the formation of any mountain on the ſides of Etna, independent of a communication with its higheſt crater,

may

may authorize us to conclude, that ſome lateral gulph may open and diſgorge fiery torrents without any ſuch communication. Such an eruption happened in 1636, when the ground, nine miles from the ſummit of Etna, opened in two places, and poured out two torrents of lava without any appearance of fire or ſmoke at the ſummit of the mountain. It is very probable that we ſhould have accounts of other ſimilar eruptions, and other mountains formed on the ſides of Etna, had the ancients ſtudied and recorded the conflagrations of that mountain, in the manner the moderns have begun to obſerve and deſcribe them.

Whatever may be the matters which cauſe and continue volcanos, it is only neceſſary that they ſhould exiſt and take fire in a place that has no communication with the central volcano, to produce partial eruptions and mountains, which may very naturally be ſuppoſed to happen.

After having ſlept at San Niccolo dell Arena

Arena the night preceding the 5th of September, I ſet out early the next morning, taking my way by the *Rocks of the Cyclops*, celebrated for the baſaltiform lavas of which they conſiſt. In this part of my journey I continually paſſed over lavas, and through ſeveral villages built upon them.

A ſhort time before I reached the rocks I was in ſearch of, a ſcene preſented itſelf, which, though foreign to my ſubject, the ſentiment of humanity and compaſſion we feel on witneſſing the misfortunes of our fellow-creatures will not permit me to paſs in ſilence.

Mount Etna has at all times been very deficient in ſprings; but when I was there the ſcarcity of water was extreme, not a drop of rain having fallen for nine months; and the rain-water which the peaſants of theſe places had collected in ciſterns being exhauſted, they were obliged to go in ſearch of it to thoſe parts of the mountain where a ſcanty ſpring might ſtill be found. Though

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In my journey up Etna I had ſufficient reaſon to notice this ſcarcity of water, by being made to pay for it much dearer than for wine at Catania, I was much more convinced of it when, on my way, I ſaw a number of women and girls carrying barrels on beaſts of burden, to fill with water at a ſpring on one ſide of the road. But the ſcene which made the greateſt impreſſion on me, I met with on my return, in the vicinity of Jaci; where I ſaw more than a hundred poor mountaineers of both ſexes, who had come thither to quench their thirſt at a ſtream of water which iſſued from the midſt of the lava. It ſtrongly excited my pity to ſee theſe wretched peaſants, all bare-footed, expoſed to a burning ſun, for the heat was then very great in thoſe low parts of the mountain; and labouring and ſweating under the load of large earthen veſſels, which they had brought on their ſhoulders and heads, a diſtance of more than ten miles, to carry home water. When they came within ſight of the ſpring, they exerted all the ſtrength they retained, haſtened their weary

ſteps, and, when they reached it, began to drink with extreme eagerneſs, without for a long time taking away their lips. How much was my commiſeration increaſed, when they informed me they were obliged to perform this laborious journey every day, that is, to employ the whole day in it; travelling from the time of ſun-riſe till noon to reach the ſpring, and from noon to the duſk of the evening to regain their habitations, and carry refreſhment to their parched families! While I was liſtening to their ſad ſtory, it chanced that one of them, a boy about thirteen years of age, in ſetting down the veſſel he carried on his ſhoulder, let it ſlip, I know not how, out of his hand, and it broke by the fall. Words can ſcarcely deſcribe the conſternation, grief, and anguiſh, with which he appeared transfixed at the accident, while with bitter tears and in broken exclamations he lamented his misfortune, and expreſſed his fears of the conſequences he apprehended to myſelf, from his being thus diſabled from carrying home to his thirſty parents

ſents the expected ſupply. As little is it poſſible to deſcribe the joy, delight, and lively ſentiment of gratitude which he expreſſed, on my giving him a ſmall piece of money, that he might buy, in a neighbouring village, another veſſel to replace that which was broken, and complete with the uſual ſucceſs his laborious journey.

Etna is not alone ſcantily ſupplied with ſprings. I have obſerved a ſimilar ſcarcity of them in the Eolian or Lipari iſlands, as we ſhall ſee in another part of this work; and if I am not miſtaken, the ſame want of them will be found in other volcanic countries; the cauſe of which appears to me evident. The rains which deſcend on mountains of this kind, either fall on bibacious tufas or ſcoriaceous matters, in which they ſink deep without again appearing on the ſurface in the lower places, becauſe they meet with no argillaceous or ſtony ſtrata to detain them; whereas ſuch ſtrata are frequent in mountains not volcanic, and produce numerous

merous dropping ſprings, fountains, and ſources of rivers, as we find in the Alps and Apennines.

When again the rains fall on the ſolid and compact lavas, they do not ſink into them, but run down their declivities, forming indeed rivers and torrents, in the rainy ſeaſon, but never true ſprings. In ſeveral parts of Etna, and eſpecially near the Grotta delle Capre, I have ſeen large furrows hollowed in the lavas, by the continued action of the rain-water.

Two hours after noon I arrived at the rocks of the Cyclops; which are likewiſe termed iſlands becauſe ſurrounded by the ſea, though they are ſcarcely a ſtone's throw from the ſhore on which the village of Trezza ſtands. It is poſſible that they might once make a part of the ſides of Etna, and have been ſeparated from them by the ſea; or they may have been thrown up out of the water by partial eruptions. I examined them, firſt making the circuit of

them in a boat, and then aſcending them to obſerve their parts.

It is immediately apparent that ſome of theſe rocks conſiſt externally only of priſmatic columns, which fall perpendicularly into the ſea, in ſome places of the length of one foot, in others two, and in others more; but it is certain that other parts of theſe rocks have not the leaſt priſmatic appearance, and are only full of very irregular fiſſures, which have divided them into irregular pieces, as we frequently ſee in common lavas.

The rocks of the Cyclops preſent another object which has not eſcaped the acute examination of M. Dolomieu; I mean the numerous and various zeolites of great beauty which are found on their ſurface, and even in the middle of their ſubſtance, where there are ſmall pores and cavities. That naturaliſt thinks, with great reaſon, that theſe noble ſtones, after the congelation of the lavas, derived their origin from the waters which filtrated through them, and held in ſolu-

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tion the particles proper for the production of zeolites. It would be a uſeleſs labour were I to attempt their deſcription after it has been ſo well given by M. Dolomieu; I ſhall, therefore, only mention what I obſerved in them when I examined them in the furnace.

If we take ſmall pieces of lava, detached from the rocks to which the zeolites adhere, leave them for ſome time in the fire, and obſerve them after they have cooled, the following are the reſults:

The zeolites, though the lava, their matrix, has not undergone a complete fuſion, are vitrified, and have flowed over the ſurface of the lava, forming a leaf of glaſs; but the greater part become globules, which, from their lucid milky whiteneſs, reſemble pearls. When examined with the lens, theſe globules are found to be full of cracks, probably cauſed by the ſudden removal of the lavas from the furnace into the cold air. This glaſs is ſemitranſparent and hard.

If we break the pieces of lava expoſed to the fire and examine the fractures, we ſhall find that only a ſemivitrification has taken place in the zeolites they contain. Some of theſe zeolitic lavas are of a homogeneous ſubſtance, but others include ſmall ſhoerls. The magnet attracts the powder of them, and ſome have polarity, attracting one end of the magnetic needle, and repelling the other.

I have but a few obſervations more to make, relative to Etna. Count Borch, not perfectly ſatisfied with the received diviſion of the mountain into three Regions, the lower, the middle, and the higher, has added a fourth, which he calls the region of ſnow; and each of the four regions he again ſubdivides into ſeveral diſtricts. I ſhall not diſpute with him theſe minute diſtinctions, which, whether they tend more to clearneſs or confuſion may be difficult to determine. I ſhall only make ſome brief remarks on his diſtrict of ſcoriæ, in the ſecond region, of which he ſays: "The diſtrict of ſcoriæ contains a

"ſurface

" ſurface of two miles entirely covered with " pumices, aſhes, and ſcoriæ."

Without noticing the ſcoriæ and aſhes, I know not what he underſtood by *pumices*. The truth is, that Etna affords none; as Dolomieu, who ſo minutely examined the mountain, has expreſsly aſſerted; and, as I took nearly the ſame road with Borch, I muſt have met with them had they been ſo plentiful as he deſcribes. The Chevalier Gioeni, likewiſe, in his account of the products of the eruption of 1787, deſcribing one which, in its configuration, reſembles the porous pumices of Lipari, remarks that this is the firſt time that Etna has ejected ſuch a kind of ſtone *.

In

* Borch is not the only perſon who has fallen into this error. Sir William Hamilton, when he viſited Etna, found there no pumices; but he was told by the Canon Recupero of Catania that the mountain produced them: the Canon, however, it is well-known, was unacquainted with the firſt principles of lithology. Baron Riedeſel, who, in this part of ſcience, was, perhaps, not ſuperior to the Canon, ſays that pumice is among the number of ſtones ejected by Etna; and joins with it

In my journey to Etna, and on my return, at the ſame time that I examined volcanic objects I did not neglect to obſerve whether the two more elevated regions of the mountain were inhabited by animals. A little beyond Monte Roſſo, I bought five partridges (*Tetrao ruſus Lin.*) of a ſportſman who had ſhot them at the upper extremity of the middle region. Theſe I had roaſted at San Niccolo dell'Arena, and they furniſhed me with two good meals. In croſſing the ſame region I met with ſeveral birds of the titmouſe ſpecies (*Parus major ; Parus cæruleus Lin.*), a kite (*Falco milvus*), thee jays (*Corvus glandularius*), two thruſhes (*Turdus viſcivorus*), and ſeveral ravens and crows (*Corvus corax ; Corvus cornix*).

the ſand-ſtone ; a production which, according to thoſe beſt acquainted with the mineralogy of volcanos, is as much a ſtranger to Etna as the pumice. One of theſe writers may, probably, have induced M. Sage to aſſert that "Etna throws out a great quantity of pumices." This groſs error was probably occaſioned by the reſemblance which, to perſons little acquainted with ſuch ſubſtances, ſcoriæ and cellular lavas appear to have to pumices.

half

half way up the higher region I ſaw no other animals, except ſome lion-ants *(Myrmeleon formicarum Linn.)* which made their pit-falls in the duſt of the lavas. There were ſeveral of them in a duſty corner of the Grotta delle Capre. As they live by enſnaring other ſmall animals, and eſpecially ants, in the ſlippery pits they form; it may be neceſſary to obſerve, that theſe are not wanting there, though I did not ſee them.

The city of Catania, during my ſtay there, amply afforded me the means of amuſement and inſtruction. The two Muſeums, the one belonging to the Prince di Biſcari, and the other to the Benedictine Fathers, beſides the various objects they contain relative to the arts and antiquities, are alſo furniſhed with a collection of natural productions, and will be found to correſpond to the great expectations that may have been formed of them from the advantageous deſcriptions of Riedeſel, Brydone, and Borch. That of the Prince is diſtinguiſhed by ſome rare ſpecimens which might adorn the richeſt

and moſt extenſive collections. But in that city a third muſeum, hitherto little known, becauſe it is new, is beginning to flouriſh. It may be ſaid it is yet in its infancy; but the infant may become a giant. The poſſeſſor and founder of it is the Chevalier Gioeni. His firſt intention was to collect the moſt curious and intereſting productions of the Sicilian ſea; and he has ſucceeded admirably. We here find dry preparations of the fiſhes moſt remarkable for their form or the rarity of their ſpecies. Among the numerous families of zoophyta, the alcyonia, the antipathes, the cellulariæ, the eſcharæ, the pennatulæ, the ſertulariæ, the milleporæ, and the iſides (corals), are not wanting; but the madreporæ and the gorgoniæ are the moſt conſpicuous for their beauty and rarity. It is equally well furniſhed with ſpecimens of the principal cruſtaceous animals of that ſea, but the numerous and choſen collection of thoſe of the teſtaceous kind is the principal ornament of the Muſeum. With reſpect to theſe, we find a practice adopted we meet with in no other cabinet. As there

there are ſome extremely minute ſhells, in ſize not exceeding a grain of ſand, which it is impoſſible to view diſtinctly with the naked eye, they are as it were loſt in the greater part of other Muſeums; but here they are placed, methodically diſtributed, at the bottom of ſmall tubes, at the other end of which is a lens; by the aid of which, the eye is enabled to diſcover the beauty of the colours, the peculiarity of the involutions, the infinite variety of the forms, the windings of the apertures, the cavities, prominences, points, threads, &c. In fine, theſe points of organized matter, by this means, equally with the larger cruſtaceous animals, afford pleaſure to the eyes of the curious, and uſeful inſtruction to the learned, for characterizing the ſpecies.

The Chevalier Gioeni, in conſequence of his reſearches relative to theſe aquatic animals, has diſtinguiſhed himſelf by the diſcovery of a new genus of multivalve conchylia, which he has already made known; but he will do himſelf much more honour

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by the publication of a work on the ſubject on which he is now employed.

He has not confined himſelf to marine productions, but has extended his diligence to terreſtrial; and the neighbouring volcano has added to his collection. We here find ſpecimens of all the Etnean products; and amid the multitude of various lavas he has collected, he has diſcovered a new ſpecies, which he has denominated *fibrous*. The method he has adopted of placing the different lavas with the ſtones and primitive rocks, from which they derive their origin, is highly inſtructive.

Equally conducive to the advancement of knowledge is the numerous ſeries of teſtaceous foſſils, which he has collected with great labour, to the north-eaſt of Etna, in a ſituation more than three hundred poles above the level of the ſea. Theſe extremely reſemble the natural which are now found in the neighbouring waters. But as the time when the ſea reached to that height is certainly

anterior to the annals of hiſtory, of what great antiquity muſt the volcano be which exiſted before that epocha!

The productions of this part of Sicily are accompanied with thoſe of the reſt of the iſland. We find a noble collection of marbles and jaſpers, with various minerals, and cryſtallized ſulphurs.

Though this Muſeum deſerves great commendation for the multiplicity and choice of the objects collected within a few years, it perhaps deſerves ſtill greater praiſe for the accurate and judicious manner in which every part of it is ſyſtematiſed; a regulation extremely neceſſary in every collection, and which it is to be wiſhed might be introduced into the two other Muſeums before mentioned.

I have been ſomewhat more diffuſe in my deſcription of this collection, becauſe it merited to be known to foreigners, who, ſhould they chance to viſit Catania, may, by its

means,

means, procure information of various productions of Sicily and the neighbouring ſea, which they might elſewhere ſeek in vain.

The Chevalier Gioeni is Profeſſor of Natural Hiſtory in the univerſity of his country, which can likewiſe boaſt of other men of genius, principally in polite literature. The natural ſciences, eſpecially thoſe which have relation to the foſſil kingdom, are not the moſt cultivated; leſs I believe from indiſpoſition towards them, than from want of encouragement. It is not the ſame with reſpect to the other two kingdoms. While I was at Catania, I had the honour to receive viſits from ſeveral perſons of learning; and I found that more than one of them had read with advantage the works of Bonnet, Buffon, and Duhamel. Among them may be diſtinguiſhed the Abbate Don Franceſco Ferrara, who afforded me the opportunity of examining the materials of the Torre del Filoſofo. The taſte for theſe extenſive branches of natural hiſtory muſt become greater, and ſpread more extenſively, from

from the laudable example ſet by Signor Ferrara, who has lately publiſhed in Sicily, *The Contemplation of Nature* of the philoſopher of Geneva (Bonnet): to which he has added, beſides my notes and thoſe of others, a great number of his own, replete with learning and good ſenſe, which muſt render ſuch a work ſtill more valuable.

END OF THE FIRST VOLUME.

Digitized with financial assistance from the
Government of Maharashtra
on 15 June, 2016